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FIRST ANNUAL REPORT

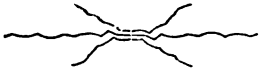
—OF THE—

AGRICULTURAL EXPERIMENT STATIONS

—OF THE—

Arkansas Industrial University,

FAYETTEVILLE, ARK.



BRANCH STATIONS:

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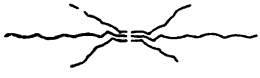

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To His Excellency, Governor J. P. Eagle.

Sir:

I have the honor to submit herewith the First Annual Report of the Experiment Stations of the Arkansas Industrial University.

I am, Sir, most respectfully, your obedient servant,

ALBERT E. MENKE,

80020

Director.

PREFACE.

IN submitting this our First Annual Report, we cannot state too strongly, that Agricultural Experiments are necessarily slow, and require the utmost care and attention to details; therefore we trust that our readers will not be too impatient for bulletins. We do not desire to publish a number of inconsequential papers, but will endeavor to issue work that is of value.

The great interest taken in our work by the White River Stock Breeders' Association, has induced them to purchase a valuable piece of land at Newport, which will be devoted wholly to grass experiments.

We cannot let this opportunity pass without publicly thanking our *volunteer* co-workers, Messrs. BORDEAUX, JARMAN AND HALE for the great personal trouble and attention that they have devoted to their experiments in order to secure thoroughly reliable results and benefit their fellow citizens.

The Peach Tree Borer—Ægeria Exitiosa Say—The great pest of the peach is a native of America. The moth appears in this State from June to September. There is only one brood per year. The eggs are laid from June to September on the bark of the trees at the surface of the ground; they are deposited singly and glued to the bark. As soon as they are hatched the larvæ or worms eat their way downward in the bark beneath the surface of the ground and feed upon the inner bark and sap-wood. The position of the larvæ can be easily detected by removing the earth from the base of the tree. They always cause a copious exudation of gum from the tree, especially when they are very numerous. The gum becomes very thick and dark. In the spring larvæ of all sizes can be found between the gum and the bark. The full grown larva is over an inch long by one-fourth inch broad. It is a whitish-yellow grub with dark head. In the University peach orchard six trees were examined and five of them were more or less injured by the borers, while one of them was nearly destroyed. The trees were four years old. In some cases the insect attacks the trees at the forks of the branches—two cases of this kind were found in our orchard. The exuded gum will always mark the place of injury.

When nearly a year old the larva is ready to change to a pupa. It then crawls to the surface of the earth and there constructs its cocoon of castings, gum and silk. The cocoon is brown in color and oval in form; usually its upper end is slightly above the surface of the ground. In this state it remains for about three weeks, when the adult moth appears and is soon ready to begin laying its eggs; thus completing the generation.

REMEDIES.

Various methods have been proposed for destroying this insect. Some of them have been useless while others have a greater or less value. The following are some of the most important methods yet proposed:

Hand Picking and Killing—Either late in the fall or early in the spring, the earth is removed from the base of every tree as far as the roots. When there is any gum present the larvæ are searched for and killed. This is a very slow method and it is very difficult to find them all, especially when they are as numerous as they are this spring in this locality. After the

larvæ have all been killed the earth should then be returned to the tree. If the work is thoroughly done this is a very effective method of dealing with this pest. Failures often result because the work was slighted.

Mounding the Trees—This method consists in mounding the trees to a height of several inches in late spring and not removing the earth until the moths are all dead in the fall. The great fault of this method is that it makes the bark of young trees too tender to endure the cold weather. Consequently, this treatment should not be used until the trees are four years old.

Bandaging the Trunk—In this remedy it is proposed to cover the trunk of the tree with straight straw, which is held in place by strings and earth. It is said to be quite effective.

Hot Water—This method has proved very effectual and is not hard to apply. In late fall or early spring the earth is removed from the base of the tree as in the first method. If any gummy substance is found it should be scraped from the tree, and in particular all holes under the bark which are filled with gum should be cleaned out. Hot water is then to be thrown against the infested part of the tree. An ordinary pail may be used for throwing the water against the trees, but a force pump would throw the water into every hole. After the water has been applied the earth should be returned to the base of the tree. This method was tried April 2, on five trees in the University peach orchard. The earth was dug away and about one gallon of boiling water was applied to each infested tree; the earth was then returned. Two days afterwards a thorough examination was made of the five trees and only one tree was found to be infested with live larvæ. They were in the bottom of a hole covered with gum. This hole was overlooked before the hot water was applied.

The Codling Moth—Carpocapsa Pomonella Linn.—There are two broods of this insect per year. For the spring brood the eggs are laid in the blossom ends of the early fruit. They hatch in about a week and the young larvæ or worms eat their way into the fruit, usually causing it to fall prematurely. When fully grown the worms eat their way out through the apple and seek some secluded spot in which to spin their cocoons and undergo their transformations. In about two weeks the adult moth appears and soon begins to lay its eggs for the

second brood in the blossom ends of the late fruit. When hatched the young larvæ eat their way into the apple, and like the first brood, when fully grown, they eat their way out through the apple and spin their cocoons in some secluded place. In this state they remain throughout the winter and in spring, about the time the apples come into bloom, the adult moth escapes and is soon ready to lay the eggs of the spring brood, thus completing the year. The moths lay their eggs at night and hide themselves during the day in some secluded place.

REMEDIES.

Various remedies have been proposed, and all except two have proved useless.

The Bandage Method—Bands of hay or cloth are tied around the trunk of the tree. When the adult larva escapes from the apple, it crawls down the trunk of the tree and finds a good place under these bands to spin its cocoon. The bands must be all looked over at least once in ten days and all larvæ or cocoons destroyed; this treatment should be kept up until the apples have been gathered. It has not been universally practiced because the labor is so great in a large orchard and oftimes the fruitgrower would neglect the work. Moreover, the treatment does not protect the present year's crop, while it would nearly always happen that some neglected orchard would always serve as a breeding place for the moths.

The Use of Poisons—This is much more effectual than the preceding method. It is done by thoroughly spraying the tree, at the right time, with Paris green or London purple and water.

In applying this remedy, Prof. Cook recommends that the following suggestions be followed:

1st. The poisons should not be too strong. One pound Paris green to one hundred gallons water. Some entomologists recommend that the mixture be a little stronger.

2d. Care should be taken to procure Paris green or London purple that is not adulterated. Failures often result from the use of adulterated poisons. Purchase of reliable firms.

3d. The application of the poison should be made in time. The best time to apply it is just as the blossoms are falling off and before the apples droop. If applied too late,

the young larva will have eaten its way into the apple and will be out of the reach of the poison.

4th. The poison should be thoroughly applied. It should reach every flower on the tree.

With ordinary care there is no danger of being poisoned. All poisons should be labeled when not in use.

The size of the orchard must determine the kind, size and cost of the force pump to be used. There are various pumps upon the market and the orchardist must select one to meet his wants

COMMERCIAL FERTILIZERS.

Chemical analysis of plants shows the presence of fourteen elements. The growth of the plant is dependent on a supply of these substances in the soil and atmosphere. The elements composing the organic part of the plant are carbon, oxygen, hydrogen and nitrogen while in the inorganic portions we find potassium, phosphorous, calcium, magnesium, sodium, iron, chlorine, sulphur and silicon. Of the organic part, the carbon, hydrogen, oxygen and probably part of the nitrogen, come from the air, while the inorganic plant-food is derived entirely from the soil. But of the different elements entering into this part of the structure, all but two, phosphorous and potassium, are found in sufficient quantities in nearly all soils. These in addition to nitrogen are the most essential elements of plant growth, and when the available supply of one or all has been removed by excessive cropping, the land is said to be exhausted or worn out. This exhausted land can be renewed by indirectly or directly replacing the supply of absent plant-food. Oftentimes a soil fails to furnish a crop with the requisite amount of one or more of the above mentioned ingredients, although it may contain an abundant supply in its composition. It is there, but not available as plant-food. When this is the case, allowing the land to lie fallow with frequent cultivation, is sometimes resorted to with good results.

By this means numerous factors are brought to bear on the unavailable store of plant-food to render it available. In addition to this, green manuring is often employed with excellent results. But when the soil lacks plant-food, this want must be met by direct application of some material containing the needed element or elements. There are two sources of supply—barnyard manure and commercial fertilizers. Of these, barn-

yard manure is in more common use, and where circumstances are such that it can be obtained, is in most cases to be preferred. It is in itself a complete fertilizer, *i. e.*, it supplies the three needed kinds of plant-food.

One ton of green barnyard manure contains from seven to twelve pounds of potash and three to ten pounds of phosphoric acid, while the nitrogen varies from eight to sixteen pounds. This variation is due to the character of the stock and nature of the food. When this means of adding plant-food cannot be employed, the farmer must go into the market for commercial fertilizer. In doing this, great caution must be exercised to avoid injudicious buying. This may arise from several causes- Dishonest manufacturers often put on the market fertilizer. which they highly recommend and sell for a price far exceeding their value. To check this kind of fraud many States sups port control stations, the duty of which is to analyze all fertilizers sold in the State. These analyses are published from time to time. Thus the farmers are kept informed as to the character of the different brands of fertilizer for sale in the State, while the manufacturers are compelled by law to state the true character of their goods.

But injudicious buying does not arise from this cause alone. Frequently fertilizers are bought, which chemical analysis shows to have the composition guaranteed by the manufacturer, the use of which results in loss to the buyer. This is due to the following reasons: Commercial fertilizers are complete and special. The complete contains nitrogen, phosphoric acid and potash. The incomplete, one or more of these. If a complete fertilizer is applied to land which needs only one of the elements of plant-food, it is as clear a case of bad economy as it would be for the same farmer to buy wire and posts for fencing purposes when he has an abundant supply of posts.

In numerous instances the more costly nitrogen is applied, when better results would be obtained from the cheaper potash. Errors of this character can be avoided by a knowledge of the nature of the soil and crop. Each farmer must determine for himself the character of the soil with which he has to deal. This can be done by any careful man in the following manner: A piece of land measuring one acre is divided into ten plots. Two of these are planted without manure. This will show the capabilities of the land without fertilizers. The remaining eight plots are fertilized with different fertilizing material. On plot 3 nitrogen is used; plot 4, phosphoric acid;

plot 5, potash; plot 6, nitrogen and phosphoric acid; plot 7, nitrogen and potash; plot 8, phosphoric acid and potash; plot 9, should be fertilized with all three of the above mentioned elements, while plot 10 receives barnyard manure. A comparison of the results obtained will give the farmer an idea as to what fertilizers are best adapted to his wants. In this way the different soils of the farm should be tested until the owner feels he understands the needs of his land. This is the only reliable method of settling this point, and each farmer must determine it for himself.

Having ascertained the wants of his soil, the buyer of fertilizers should carefully consider the crop to be raised. Some plants require but little potash but are greedy for nitrogenous food. This is the case with the wheat plant; potatoes demand more potash and less nitrogen.

To determine whether the price asked per ton for a fertilizer is a fair one, the buyer should multiply the number of pounds of each element of plant-food by the market price and add to this the cost of bagging (about $2.80 per ton) and freight rates from shipping point. A fair estimate will thus be obtained of its true value.

Below is given the prices of the different fertilizing ingredients at the factories in Memphis and St. Louis:

Trade Value of Fertilizing Ingredients in Raw Materials and Chemicals.

	Cents per pound.
Nitrogen in ammonia salts	18
" nitrates	16½
" dried and fine ground fish	18
Organic nitrogen in fine ground bone	16½
" " " fine medium bone	14½
" " " medium bone	12½
" " " course medium bone	10½
" " " coarse bone, horn shavings, hair and fish scrap	8½
" " " dried and fine ground blood	16½
" " " cotton seed (valued at Little Rock or Ft. Smith)	7

Phosphoric acid soluble in water	8
" " " " ammonium citrate	8
" " insoluble in either of above, in fine bone	7
" " " " " " fine medium bone	6
" " " " " " medium bone	5
" " " " " " coarse medium bone	4
" " " " " " coarse bone	3
" " " " " " fine ground rock phosphate	2
Potash as kainite	5
" as muriate	5
" as high grade sulphate	6

These prices are intended to represent the commercial and not the agricultural value of the ingredients.

Explanatory Notes.

Nitrogen, Source and Nature.—The nitrogen found in commercial fertilizers is supplied by the use of ammonium salts, ground fish, ground blood, cotton seed, etc. Its adaptability as a plant-food varies with its source. The nitrogen in the above mentioned substances is readily yielded as plant-food, while leather scraps and wool waste must remain in the soil a long time before the nitrogen contained in them becomes available plant-food.

Phosphoric Acid.—In connection with calcium this occurs in S. C. rock, Canadian apatite and bones as calcium phosphate. In these substances it is insoluble, but when treated with sulphuric acid it is converted into a soluble form and is known as superphosphate. When this superphosphate is applied to the soil, or remains stored for a long time, it assumes an insoluble form and is known as the "reverted" phosphoric acid. Thus we have three forms:

Soluble.
Reverted.
Insoluble.

The soluble and reverted are agriculturally and commercially the more valuable, while the insoluble varies in value, due

to the source from which derived. Manufacturers who obtain their supplies from bone, claim that the bone not being as compact as the rock, is more readily acted upon by the solvent agents of the soil, and thus the acid is the more freely rendered available.

Potash.—This is the plant-food more frequently lacking in light sandy soils. The supply is usually derived from kainite, muriate of potash, and high grades of sulphate of potash, wood ashes and the ash of cotton seed hulls are rich in their substance. Clay soils carry an abundant supply, and many minerals have a large per centage in their composition.

In order to ascertain the condition of the fertilizer market in Askansas, the following analyses were undertaken. From time to time further bulletins will be issued from this department of the station, relating to this subject, and thus we shall endeavor to guard the farmers of the State in as far as possible from the losses arising from the purchase of worthless fertilizers. Analyses of all fertilizers will be made free of charge for any farmer in the State who shall ship the same to us in accordance with the instructions given. But in justice to all parties concerned, we must refuse to have anything to do with samples selected under other conditions than those laid down.

Fertilizers Analyzed at the Arkansas Agricultural Experiment Stations.

No.	NAME OF BRAND.	NAME OF DEALER AND MANUFACTURER.	SAMPLED BY.	DATE OF SAMPLING.
1	Homestead Phosphate	Michigan Carbon Works, Detroit, Mich.	E. Richards	
2	Homestead Corn and Tobacco Grocer	Michigan Carbon Works, Detroit, Mich.	E. Richards	
3	Complete Fertilizer	L. E. Archias, Fayetteville, Ark. / A. B. Meyer & Co., St. Louis, Mo.	C. B. Collingwood	March 23, 1888.
4	Ground Bone Meal	L. E. Archias, Fayetteville, Ark. / A. B. Meyer & Co., St. Lou s, Mo.	C. B. Collingwood	March 21, 1888.
5	Unleached Wood Ashes		S. S. Twombly	March 22, 1888.
6	Leached Wood Ashes		S. S. Twombly	March 22, 1888.
7	Ground Bone			
8		Memphis Fertilizer Company	James W. James	March 26, 1888.
9	Kainite	Zell Company, Baltimore, Md.	S. S. Twombly	
10	Superphosphate	Bruner Company, St. Louis, Mo	S. S. Twombly	
13	Acid Phosphate	Zell Company, Baltimore, Md	S. S. Twombly	
14	Sulphate of Ammonium	Bruner Company, St. Louis, Mo	S. S. Twombly	
15	Floats	Zell Company, Baltimore, Md	S. S. Twombly	
16	Cotton Seed Hull Ashes	Pine Bluff, Ark.	A. F. Cory	
17	Ammoniated Phosphate	Memphis Fertilizer Company	C. B. Collingwood	
18	Dried Blood	Mapes' Manufacturing Company	S. S. Twombly	
A	Ammoniated Bone	Chicago, Ill.	F. M. Bordeaux	
B	Stern's Superphosphate	Stern & Co., New Orleans, La	F. M. Bordeaux	

Fertilizers Analyzed at the Arkansas Agricultural Experiment Station.—Continued.

No.	PHOSPHORIC ACID.								NITROGEN.		POTASH.		MOISTURE.		VALUE PER TON.	
	SOLUBLE.		INSOLUBLE.		REVERTED.		TOTAL.									
	Claimed	Found.	Claimed	Found.	Claimed	Found.	Claimed	Found.	Claimed.	Found.	Claimed.	Found	Claimed	Found.	Price.	Value.
1	7 to 10	9.23	.....	1.32	1	1.09	.....	11.64	1.85to2.4	1.80	1.7	1.53	.....	15.88	$40.00	$25 58
2	8 to 9	7.84	.....	1.29	2	3.95	.....	13.08	3. to 4	2.98	3.7	4.35	.....	8.08	60 00	34 97
3	4.21	3.92	7.09	6.84	3.73	0.33	15.03	11.09	2.65	1.70	.....	1.14	.....	9.37	40 00	19 23
4	.....	.....	.....	.....	.....	.....	22 to 25	23.10	4½ to 5	3.51	.....	2.24	.....	7.57	40 56	32 50
5	.....	.....	.....	.....	.....	.....	.....	1.97	.....	.....	.....	5.16	.....	0.00	.....	6 74
6	.....	.....	.....	.....	.....	.....	.....	1.50	.....	.....	.....	0.91	.....	0.30	.....	2 11
7	.....	.....	.....	.....	.....	.....	.....	15.88	.....	3.82	.....	2.73	.....	7.50	.....	28 05
8	.....	5.23	.....	7.23	.....	2.87	.....	15.24	.....	2.88	.....	3.34	.....	8.80	.....	19 49
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17.92	.....	0.81	*14 00	17 92
10	.....	10.07	.....	8.82	.....	2.21	.....	21.10	.....	0.65	.....	0.60	.....	6.79	20 00	29 64
13	.....	10.50	.....	3.21	.....	0.23	.....	13.94	.....	.....	.....	0.75	.....	12.63	*13 00	20 49
14	.....	.....	.....	.....	.....	.....	.....	.....	18 to 19	16.18	.....	.....	.....	3.50	70 00	58 25
15	.....	.....	.....	.....	.....	.....	.....	22.32	.....	.....	.....	1.29	.....	1.51	*12 00	10 22
16	.....	.....	.....	.....	.....	.....	.....	8.80	.....	.....	.....	9.71	.....	8.27	16 00	16 95
17	.....	3.90	.....	7.18	.....	0.20	8 to 10	11.28	2 to 3	1.94	2 to 3	3.40	.....	11.28	23 50	22 78
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.14	.....	.....	.....	11.06	42 30	40 06
A	.....	6.79	.....	2.81	.....	1.14	.....	10.74	.....	1.64	.....	0.94	.....	13.25	.....	19 94
B	.....	7.91	.....	1.78	.....	2.11	.....	11.80	.....	1.41	.....	1.80	.....	17.83	†22 50	24 13

*Value in Baltimore. †Value in New Orleans for car lots.

Instructions for Sampling Commercial Fertilizers for the Arkansas Agricultural Experiment Station.

The commercial value of a fertilizer can be estimated, if the percentages of the principal fertilizing elements are known. Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the fertilizer. The accompanying instructions, if faithfully followed, will insure a fair sample. Special care should be observed that the sample neither gains nor loses *moisture* during sampling or sending, as may easily happen in extremes of weather, or from even a short exposure to sun and wind, or from keeping it in a poorly closed vessel.

First—Provide a cup, some large papers, and for each sample a glass fruit can or tin box, holding about one quart, that can be tightly closed, all to be clean and dry.

Second—Weigh separately at least three (3) average packages (barrels or bags) of the fertilizer, and enter these actual weights in the "Form for Description of Sample."

Third—Open the packages that have been weighed and mix well together the contents of each, down to one half its depth, emptying out upon a clean floor if needful, and crushing any soft, moist lumps, in order to aid mixture, but leaving unbroken hard, dry lumps, so that the sample shall exhibit the texture and mechanical condition of the fertilizer.

Fourth—Take out five (5) equal cupfuls from different parts of the mixed portions of each package, pour them (15 in all) one over another upon a paper, intermix thoroughly but quickly to avoid loss or gain of moisture, close tightly, *label plainly*, and send, charges paid, to the

ARKANSAS AGRICULTURAL EXPERIMENT STATION,

Fayetteville, Ark.

Form for Description of Sample for Analysis at the Laboratory of the Arkansas Agricultural Experiment Station.

The person sending samples to the station for gratuitous analysis, will be provided with a form like the following for each sample, and must fill up every one of the blank particulars given, so as to make the description complete and definite. The writing should be plain and legible:

After filling the form it may be used as a table by mapping with the sample.

If any printed circular, pamplet, analysis or statement accompanies the fertilizer, or is used in its sale, send copy with the specimen.

1. Brand fertilizer.

.....

2. Name and address of manufacturer.

.....

3. Name and address of dealer from whose stock this sample is taken.

.....

4. Date of taking this sample.

.....

5. Selling price per ton, bag or barrel.

.....

6. Selling weight claimed for each package weighed.

.....

7. Actual weights of packages opened.

.....

8. Copy of analysis or guaranteed composition affixed to packages of this fertilizer.

.....

9. Signature and P. O. address of person taking and sending this sample.

.....

DEHORNING.

The subject of dehorning having become one of great interest, we undertook a series of careful experiments with a view to clearly observing the pathological changes produced in the animals, and also to notice what effect the operation had upon the composition of the milk. It is obvious, from the results undermentioned, that the milk did not materially change in the proportion of fats to solids not fat. Owing to hot, dry weather our pasture became poor and all stock suffered; the pasture had water in it, and the stock was weighed at the same period every three days in order to check any abnormal weighings from water. The loss of weight observed was tolerably constant before and after dehorning. Towards the end of the experiment we had some rain; the pasture improved with a consequent gain. Four steers were dehorned at the Tennessee station, in March, with the following results as to weight:

WEIGHTS OF FOUR STEERS.

March.	No. 1.	No. 2.	No. 3.	No. 4.
1	1200	1170	1030	1155
2	1205	1175	1032	1156
3	1202	1175	975	1125
4	1205	1180	1000	1100
5	1210	1175	980	1080
6	1215	1180	990	1085
7	1210	1185	992	1075
31	1255	1220	1035	1140

It is more probable that the loss of weight we observed was due to poor pasture rather than the dehorning. We are, however, not inclined to take up an absolute position on this point. The Tennessee results are quoted as they bear on the fact under discussion. Steers 1 and 2 were fed ensilage; 3 and 4, wheat straw. We intend to keep the cows under observation for a year or more, making monthly examinations as heretofore. They will not be treated in any way different from the rest of the herd.

Plate I. Section of Horns Amputated at Base.

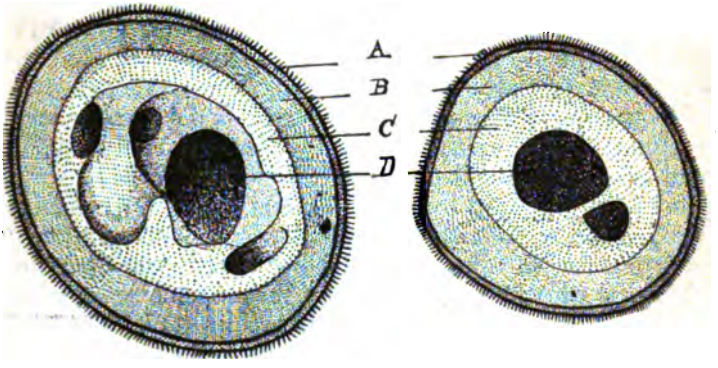
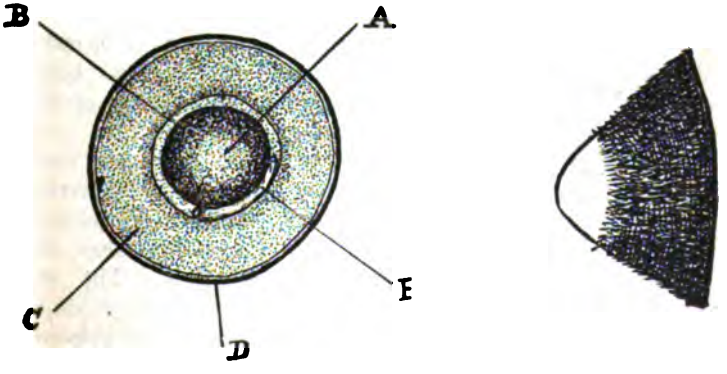


FIG. 1.—Cow three years old.
FIG. 2.—Cow four years old.
A.—Epidermis.
B.—Corium.
C.—Bony core of horn.
D.—Cavity of horn core.

Plate II. Section and side view of Horns of Calf four months old.



A.—Cartilaginous horn core partly ossified.
B.—Its periosteal covering.
C.—Corium.
D.—Epidermis.
E.—Artery.

Amputation of the horns was performed at this station on seven subjects, in all of which the physiological condition of the animals was noted for sometime prior and subsequent to the operation, while two were under special observation with reference to the effect produced on the milk secretions

The animals were all kept as nearly as possible, under similar conditions before and after being dehorned, in order that whatever changes might be observed could reasonably be regarded as effects produced by that operation. Several means were employed in the different cases in order to ascertain, for the benefit of those who may feel inclined to practice the operation on their own cattle, which is the most effective and readily available way of securing the animal to be operated on. The method of restraint found to be most suitable, as well as the manner of operating on calves and adults, is given below:

Cow No. 1, four years old, native stock, arrived on farm June 18th; was weighed and examined as to temperature, pulse and respiration every third day till July 5th.

The record shows a steady decrease in weight from the day of arrival up till the 26th of July, while the average temperature was 102.5° F. The pulse and respiration in cows vary so much under the influence of digestive and other physiological processes, as well as external conditions of temperature, etc., that they cannot in general (at least so far as their frequency is concerned) be regarded as of much diagnostic value.

July 5th cow No. 1 was secured in stanchion and horns amputated by knife and saw. Slight bleeding occurred from two small vessels at the anterior part of the stump, but soon ceased spontaneously. After sponging, the wounds were covered by carbolized cotton and a bandage applied.

July 9th the bandage was removed and new dressings applied. The discharge was slight and healthy in character. The parts after this were smeared with grease to prevent adhesion of dressings, the outside of bandage being also covered with tar ointment to prevent the attack of flies. The wounds were sponged and dressings renewed every five or six days.

Granulations began to spread and narrow the openings in the stumps in about two weeks after the operation, while the discharge gradually diminished in amount.

Cow No. 2, three years old, was secured and dehorned in the same way, also on July 5th.

The subsequent treatment was similar to that of No. 1. On the 10th the frontal sinus on one side was found full of a

dark-colored, thin, serous fluid, which escaped at times by the nostril; afterwards this fluid became clear.

The other animals dehorned were a six-year-old cow, one two years old, one heifer seven months old and two calves. The cow was thrown by ropes and tied and the head held in position by assistants while the horns were taken off by the saw alone.

This method of restraint is entirely unsuited for such an operation. Besides the delay and risk of injury from throwing, the head cannot be held so steady as by the method of securing in the stanchions.

A heifer, seven months old, was dehorned June 20th. Secured by lashing neck and body to one side of a board fence, while the head was bent around the terminal post and tied by a rope halter to the opposite side of the fence. The horns were removed by the saw alone. This manner of fastening the head was found defective, allowing too much play and rendering the operation difficult by interfering with the movements of the saw.

June 9th, a calf, four months old, with horns projecting about one inch, base broad and movable, was thrown and feet tied together by a rope.

A circular incision was made round the base and the horn, along with the spongy bone tissue beneath, to the depth about one-quarter inch, removed by an ordinary bone gouge. Hemorrhage was repressed by tincture of iron and the parts covered by cotton and bandage. After the first dressing they were left uncovered and merely smeared with tar ointment. There was little discharge from the wounds, and healing ensued in about six weeks.

June 20th, calf six weeks old, horns about one-half inch long, soft and freely movable, was thrown down and held with head on the floor and the embryo horns taken out, along with some of the bone beneath, by means of a circular gouge—the ordinary punch formerly used for cutting gun wads. This instrument, when sharp, answers every purpose for the operation on calves.

There was but little bleeding or struggling, and the whole proceedings did not occupy more than three minutes. The holes were covered by cotton, without any bandage. So far as could be observed, the operation on these two calves produced no effect on their appetite or weight. The wounds necessarily suppurate and take several weeks to heal, but the operation is

less serious and much more easily performed than on the older animal, and the ultimate result equally satisfactory.

The records of weight and temperature on this calf are here given:

No. 5, calf six weeks old—

	WEIGHT, POUNDS.	TEMPERATURE, F.
June 18	126	101.8
20	134	102.5
One hour after dehorning		103.2
21	137	102.5
25	136	102.8
29	140	103
July 2	146	102.4

Cow No. 1.

	RECORD OF WEIGHT.	TEMPERATURE.
June 18	800	
25	784	
29	781	
July 5	774	102.8
One hour after operation		103.5
Four hours later		103.3
July 6	763	103.8
9	756	105.5
10	742	105.2
11	760	105.4
12	726	105
14	720	104.2
16	731	103
19	722	102.5
30	732	
Aug. 2	765	
6	786	

Cow No. 2.

June 18	640	102.7
25	626	
July 5	604	103
Four hours after operation		103.2
July 6	609	103.2
9	608	103.4
12	593	103.2
16	581	102.5
26	572	102.5
30	574	
Aug. 2	573	
6	586	

From these records it is seen that, in the case of the cows marked 1 and 2, there was a gradual and nearly constant loss of weight, both before and after dehorning, which was probably due to change or deficiency of pasture or to excessive heat, causes which were in operation throughout the whole experiment. No part of this loss can, therefore, with certainty, be attributed to the operation of dehorning.

The appetite of the cows was not at any time interfered with.

The degree of fever, indicated by the thermometer, showed in one case a rise of temperature to 105° F. The normal temperature of cattle (taken in the rectum) may be placed at 102° F.

The other cows and calves that were dehorned earlier and removed from the farm shortly afterwards, rapidly improved in condition after the first two weeks.

The effect produced on the milk secretion is given on another page.

Although these experiments were conducted during the fly season, and therefore under unfavorable conditions, the results show that amputation of the horns, either in calves or grown animals, is followed by only slight constitutional disturbance.

Healing takes place by the formation of granulations on the soft tissue of the matrix, and also on the surface of the bone, and later by the contraction and growth of the skin over the sore On account of the large size of the wound the process is necessarily prolonged.

Suppuration is not an abnormal result of dehorning, but the natural and constant condition of all open wounds.

Although healing usually progresses favorably after dehorning, the experience of others shows that such wounds sometimes take on an unhealthy action and continue to discharge for months. This is most likely to occur when the horns are taken off either too close or too far from the head; when the animal is in poor health at the time of the operation, or when foreign bodies become lodged in the sinus. When a large number are dehorned at one time, and kept together in the same stable, an unhealthy condition of the wounds may ensue, and infect the entire herd.

Such complications are not common, but ought to be considered before forming an opinion on the question of dehorning.

Indiscriminate dehorning of all cattle cannot be recom-

mended, but in the case of vicious animals of either sex there need be no hesitation in removing these dangerous weapons.

The benefits claimed to result from dehorning have been generally as follows: There is an improvement in the disposition of the dehorned animals, and as a consequence, a greater tendency to the secretion of milk and laying on of fat. Less space is also required for feeding, while injury of other stock and of human beings by the horns of vicious animals, is avoided.

The experience of many farmers who have had their cattle dehorned shows that where bulls and steers are to be fattened during winter in sheds and close yards, the horns may with profit be removed in the fall, while others claim equally good results from the dehorning of milch cows.

So far as has yet been observed, removal of the horns has no effect in deteriorating the quality of the milk.

From our analyses it is seen that the butter producing elements of the milk are not diminished while the cows are suffering from the effects of the operation, and it is even less likely that this should occur after they have recovered.

The practice of dehorning, however, is always open to the charge of cruelty, and on this account is not likely to ever become general.

The operation on calves is less objectionable in this respect, and should always be preferred to the more serious and painful operation on older animals.

It is best performed when the calves are from three to seven or eight weeks old, soon after the horn shows itself above the skin. Removal of the small, movable button of horn is not sufficient to prevent further growth, but part of the soft, spongy bone beneath should also be removed. The circular gouge before mentioned is the only instrument necessary. By a rotatory movement the skin is cut down to the bone around the base of the horn, and by depressing the hand and slight lateral motion the bone is easily removed for sufficient depth.

The skull wall is, at this age, solid at the base of the horn and very thick, soft osseous tissue filling up the space which afterwards, by absorption, becomes part of the frontal sinus. Bleeding usually ceases spontaneously; if excessive, it may be controlled by cold water or pressure by pad held in place by a bandage.

The only after treatment is to keep the part clean by occasional washing with an antiseptic solution, such as carbolic acid, one part to fifty of water.

Dehorning, after the fourth or fifth month must be done by the saw, as the horns are then usually too large to admit the use of the gouge.

With increasing age, the anatomy of the parts at the base of the horn becomes modified, the spongy osseous tissue of the calf being absorbed, leaving a space between the two tables of the bone which is known as the frontal sinus. The central cartilaginous structure of the embryo horn of the calf also becomes ossified, unites to the frontal bone, and finally becomes hollowed out in the center. The cavity thus formed extends to the extremity of the horn cores and is continuous with the frontal sinus, and through another sinus with the nasal chambers. This explains why collections of blood or pus in these cavities sometimes escapes by the nostrils, and also explains why the air during respiration rushes in and out of the openings caused by dehorning.

The sinuses have no communication with the cranial cavity, and inflammation and suppuration of the membranes of the brain which has been said to result from dehorning, is one of the most unlikely of complications. The horn core ceases to grow in length when adult age is reached, while the horn crust continues to be produced in sufficient amount only to repair the superficial waste.

The horns are epidermal appendages, analagous in structure and growth to the human nail.

The skin at the base of the horn is thickened, forming a tough fibrous ring covered to some extent by the thin bevelled edge of the horn crust.

Both constituent structures of the skin, corium and epidermis, are continued into the horn, the superficial epidermal cells being modified to form the horn crust, while a thin prolongation of the corium, covered by the deepest layer of the epidermis, is continued over the horn cores, forming the matrix of the horn. It is from these deepest cells of the epidermis, both at the base of the horn and along the core, that the crust grows in length and in thickness. The soft structures at the base of the horn, severed in amputation, are only moderately vascular, although statements as to the extreme vascularity of these parts are often made. The blood supply is obtained chiefly from two small vessels, which, formed by division of a branch situated above the orbit, encircle the anterior part of the horn base and send branches outward into the osseous core and its covering.

When excessive bleeding results from dehorning, it usually comes from vessels situated in the bone, which, from their rigid surroundings, do not contract at their cut ends as in the soft tissues.

From these remarks on the anatomy of this region, it will be seen that the proper place to operate so that the horn may not be reproduced, is internal to the secreting cells of the matrix at the base. None of the horny tissue should ever be left on the stump.

In cows under three years of age, the vascularity of the part and the tendency of the horn to grow again, are greater than in older animals.

The method of restraint found to be most satisfactory in these experiments was by the use of a stanchion constructed in the usual manner, the neck being imprisoned hetween two vertical pieces of two by four scantling. In order to restrain the movements of the head the end of a long 5/8-inch rope was converted into a halter. This is done by making a small loop on the end of the rope. After laying this over the neck just behind the ears, the rope is doubled about three feet from its end and the doubled portion passed through the loop from behind forwards and drawn tight over the nose. The head was then drawn close to the second upright of the stanchion on the right to which the rope was fastened by several turns around it, the remainder being carried over the neck and secured to the second upright on the left.

By this means, although the head was not absolutely fixed, sufficient steadiness was obtained to allow free working to the saw on both sides,

If this should in any case be found to allow too much play to the head, it can be further fixed by means of a second rope attached to the halter on both sides below the level of the eye, passing under the throat and drawn tightly around the upright to the left of the stanchion.

The tools necessary are a knife and a saw. The knife should be clean and sharp, and the saw should run easily. The saw used by butchers is quite as suitable as any other. Our work here was performed by means of an instrument sold by H. H. Haaff, of Chicago, and constructed specially for dehorning. This saw has an extremely narrow blade, one end of which is fastened to a pivot which allows it to twist laterally in both directions

The advantages of this arrangement are on the negative side, but by a little extra care, the instrument was made to answer the purpose.

Amputation may be performed by the saw alone, but the use of the knife at the first and last points of the operation causes less pain to the animal and leaves a cleaner cut surface.

With the knife, make a rapid cut down to the bone around the upper part and about one-half inch internal to the margin of the horn crust; separate the cut tissues and saw from this incision to a corresponding point below, holding the horn in position with the left hand till the bone is completely severed, then complete the process with the knife.

By running the saw too close to the head the wound is made unnecessarily large and the healing process correspondingly delayed, while running it too wide is apt to be followed by stub horns.

After both horns are removed it is desirable to cover the parts with tow or cotton and a bandage. If the bleeding does not soon cease it shquld be controlled by cold water or, if necessary, by styptics and pressure. The wounds should not be interfered with afterwards any more than necessary.

If the discharge becomes offensive in oder they should be washed with solution of carbolic acid and the dressings frequently changed.

The best time to operate is in the spring, fall, or winter. When a large number of cattle are dehorned at one time they should not be kept crowded in the same stable. The illustrations show the appearance of the horns removed from cows Nos. 1 and 2, the stumps remaining on the head of course corresponding.

Although our experience with dehorning is insufficient to warrant us in recommending the practice on any extensive scale, the results of these experiments must be considered as favorable to the operation when performed on suitable subjects.

The conclusions arrived at may be thus formulated:

(1.) The operation requires some care, but is not difficult or dangerous.

(2.) The wounds heal favorably as a rule, although in exceptional cases and when the operation is improperly performed, continued suppuration and chronic inflammation may ensue and seriously interfere with the health of the animal.

(3.) In cases that progress normally, from three to four months may be given as the time which elapses before complete healing occurs.

(4.) When amputated at the proper place the horns do not return.

(5.) The constitutional disturbance is not severe, and is manifested by a slight and temporary rise of temperature, with probably, in most cases, a slight decline in weight and milk secretion, lasting over the first week or so.

(6.) The quality of the milk is not injuriously affected.

(7.) The operation must be considered painful, but there is no evidence that the pain is excessive after the operation is over.

On calves we conclude that—

(1.) The operation is less painful than in adults.

(2.) When removed as above directed the horns do not return.

(3.) There is little constitutional disturbance manifested.

(4.) When the animal is healthy the wounds heal favorably in about six weeks or two months.

COW No. 1.

DATE.	WEIGHT OF COW.	WEIGHT OF MILK. OUNCES.	TEMPERATURE OF COW.	PER CENT. OF TOTAL SOLIDS.	PER CENT. OF FAT.
Jun. 18	800	.....	.....	.....	.....
20	.....	208	.....	14.72 14.68	5.21 5.19
21	.....	191	.....	15.08 15.01	5.47 5.47
22	.....	198	.....	14.60	5.18
23	.....	182	.....	.....	.....
25	784	195	.....	.....	.....
26	.....	172	.....	14.69 14.67	5.24 4.99
27	.....	176	.....	13.90 14.02	5.05 4.97
28	.....	179	.....	14.75	5.30
29	781	178	.....	13.96 13.87	4.87 4.90
30	.....	179	.....	14.35 14.45	5.21 5.08
July 2	.....	178	.....	14.05 14.07	4.82 4.98
3	.....	179	.....	13.94	5.11 5.09
4	.....	182	.....	.....	.....
5	774	145	102.8 103.5*	15.25 15.34	4.83
6	763	107	103.8	15.20 15.27	5.49 5.49
7	.....	127	103.8	14.79 14.80	5.58 5.56
9	756	126	105.5	15.30 15.30	5.81 5.67
10	742	92	105.2	.....	.....
11	.....	95	105.4	15.24 15.31	.....
12	726	126	105.0	15.14 15.23	5.50 5.63
13	.....	132	.....	14.88 14.78	5.74 5.72
14	720	126	104.2	15.02 15.10	5.82 5.93
16	731	135	103.0	15.14 15.10	5.68 5.77
17	.....	153	.....	14.12 14.24	5.06 5.09
18	.....	143	.....	.....	.....
19	722	166	102.5	14.58 14.47	5.13 5.26
20	.....	159	.....	.....	.....
21	.....	.....	.....	.....	.....
23	.....	147	.....	.....	.....
26	.....	.....	102.0	.....	.....
31	732	145	.....	.....	.....
Aug. 1	765	.....	.....	.....	.....
6	786	166	.....	.....	.....

*Four hours after dehorning.

COW No. 2.

DATE.	WEIGHT OF COW.	WEIGHT OF MILK. OUNCES.	TEMPERATURE OF COW.	PER CENT OF TOTAL SOLIDS.	PER CENT OF FAT.
Jun. 18	640	.....	102.7	.....	.....
20	.....	193	.....	14.38	4.98
				14.41	5.18
21	.....	183	.....	13.25	4.47
				13.26	4.66
22	.....	179	.....	13.24	4.80
				13.28	4.69
23	.....	168	.....	.....	.....
25	626	.....	.....	.....	.....
26	.....	182	.....	13.21	4.33
				13.18	4.29
27	.....	185	.....	14.12	5.15
				14.16	5.14
28	.....	174	.....	13.54	4.46
				13.53	4.45
29	.....	176	102.2	12.91	4.25
				12.98	4.23
30	.....	163	.....	13.73	4.84
July 2	.....	134	.....	14.31	5.06
				14.24	4.93
3	.....	142	.....	13.90	5.17
				14.07	5.23
4	.....	151	.....	.....	.....
5	604	149	103.0	13.18	4.60
			103.2*	13.12	4.60
6	609	106	103.2	13.50	4.87
				13.91	5.23
7	.....	120	103.5	13.90	4.97
				13.90	
9	608	145	103.4	13.71	4.72
				13.61	
10	.....	112	102.6	13.72	4.83
				13.79	4.89
11	.....	133	.....	13.74	4.46
				13.74	4.48
12	593	132	103.2	13.89	4.82
				13.89	4.83
13	.....	141	.....	13.11	4.71
				13.29	4.60
14	.....	139	.....	13.62	4.73
				13.56	4.51
16	581	136	102.5	13.40	4.67
				13.51	4.74
17	.....	152	.....	13.67	4.69
				13.59	
18	.....	142	.....	.....	.....
19	.....	173	102.0	.....	.....
20	.....	161	.....	.....	.....
21	.....	67	.....	.....	.....
23	.....	91	.....	.....	.....
26	573	.....	.....	.....	.....
31	574	134	.....	.....	.....
Aug. 1	573	.....	.....	.....	.....
6	586	134	.....	.....	.....

*Four hours after dehorning.

The above analyses were made according to the method of Dr. Babcock, described in the report of the Association of Official Agricultural Chemists for 1888.

	WEIGHT—POUNDS.	MILK—OUNCES.
COW No. 1.—Aug. 11	810	148
COW No. 2.—Aug. 11	622	145

January 4, 1889, all dehorned stock in good condition except a seven-month old heifer, dehorned June 20th, when the horns were in active growth, but too large to be removed with a gouge; although the horns of this animal were taken off close to the head, there is now an appearance of stub-horns. The other animals are perfect mooleys. The calf's have a little excresence of the skin not visible, but which can be felt with the fingers. It is entirely cutaneous, and will not increase in size. As before stated, the best time to dehorn is when quite young.

WHEAT.

LAND.—A sandy loam.

MODE OF CULTIVATION.—Plowed and harrowed twice; a few small rocks remaining were raked off.

MODE OF COVERING AND PREPARATION OF SEED.—In order to avoid any danger from smut the seed was treated with bluestone (sulphate of copper) in the following way: The amount of sulphate of copper used was twenty ounces to eight bushels of seed. Dissolve the sulphate of copper in warm water, allow it to cool, then put in enough cold water to cover the wheat when added. Allow the wheat to stand in it for some time. It is then taken out and dried in the sun. It is now ready for use. We drilled our seed, using a Buckeye rear pressure shoe drill, an implement that does well in a loose soil.

The following table shows varieties tested, date of sowing, and yield:

VARIETY.	DATE OF SOWING.	DATE OF HARVESTING.	YIELD BU. PER ACRE.	WHENCE OBTAINED.
Golden Seal	Sep. 21	June 14	23⅓	Mock & Co., Osborn, O.
Poole		" 7	25⅔	Patterson Bros., Windfall, Ind.
White Hybrid		" 7	24⅓	P. Henderson & Co., N. Y.
Fultz		" 6	41⅓	
White Russian		" 7	26½	
Early Rice		" 12	23	Patterson Bros., Windfall, Ind.
Med. Hybrid		" 12	25⅔	
Roscoe		" 12	29⅓	Josenhaus, Owosso, Mich.
Fulcaster		" 12	30 5-6	Dept. Agriculture, Wash. D. C.
Wyandotte Red		" 14	26⅓	Balliet, Nevada, O.
Diamond Bearded		" 7	29⅓	Archias, Fayetteville, Ark.
Deitz Longberry	Sep. 24	" 11	21½	Everitt & Co., Indianapolis.
Martin's Amber		" 11	23⅓	
Rocky Mountain		" 6	23½	
New Monarch		" 7	36 1-6	
Everitt's High Grade.		" 11	31⅔	
Golden Prolific		" 12	23½	
Tasmania Island		" 11	13⅔	
Ruby	Oct. 5	WinterKilled		Prof. Blount, Ft. Collin, Col.
Rust Proof				
Hybrid No. 10				

The New Monarch, Everitt's High Grade, Fulcaster and Fultz, having given the best yield, a more detailed description is appended.

EVERITT'S HIGH GRADE.—Smooth heads, white chaff, red grains, heads tolerably large, solid, broad and closely set, grains well inclosed with closely fitting chaff, large, hard or flinty, color red, straw strong.

NEW MONARCH.—Heads long, beardless, well filled, good straw, an excellent variety.

FULTZ.—Fultz wheat is beardless, white glabrous, fairly compact, slender, nearly square, tapering; grain dark, medium, short, fairly plump. This variety gave the largest yield, 41⅓ bushels to the acre.

FULCASTER.—This variety is a cross between Fultz and Lancaster. It is an excellent grain, and can be well recommended.

EXPERIMENTS WITH FERTILIZERS.—We tried several experiments with commercial fertilizers. The results obtained showed that nitrogen, either as an ammonium salt, or as a nitrate, gave the best results. Potash salts, ground bone, superphosphate, floats alone, or in mixture without nitrogen in some form did not pay the extra cost. Where an increased yield that was of an importance sufficient to justify further attention was obtained, may be found in the following table:

FERTILIZER USED.	POUNDS PER ACRE.	YIELD BUS. PER ACRE WHEN UNFERTILIZED.	YIELD BUS. PER ACRE WHEN FERTILIZED.	VARIETY OF WHEAT.
Ammonium Sulphate..	200	25⅔	32	Mediteranean Hybrid.
Sodium Nitrate.....	275	21½	33½	Deitz Longberry.
Sodium Nitrate.....	275	30 5-6	40½	Fulcaster.
Super-Phosphate	400			
Ammonium Sulphate..	100	23	29	Early Rice.
Sodium Nitrate.....	150	23⅓	28 5-6	Martin's Amber.
Sodium Nitrate.....	100	23⅓	25	Golden Seal.

COST OF FERTILIZERS.

	PRICE PER TON IN ST. LOUIS.
Ammonium Sulphate	$70 00
Sodium Nitrate	60 00
Super-Phosphates	20 00

GRADING OF WHEAT.—We had two objects in view when we had the wheat graded. We worked not only to notice the relative grades of the different varieties, but also to see what effect fertilizing had upon them. We here desire to express our thanks to the Redmond-Cleary Commission Company, of St. Louis, who had the grades established for us and put themselves to considerable trouble to further our results.

ST. LOUIS BOARD GRADES.

VARIETY.	FERTILIZED.	UNFERTILIZED.
Golden Seal	4 Winter.	4 Winter.*
Poole	3 Red.	3 Red.
White Hybrid	3 White.	4 Winter.
Fultz	3 Red.	4 Winter.*
White Russian	3 Red.	3 Red.
Early Rice	3 Red.	4 Winter.†
Med. Hybrid	3 Red.	4 Winter.
Roscoe	4 Winter.	4 Winter.
Deitz Longberry	3 Red.	4 Winter.*
Martin's Amber	4 Winter.	4 Winter.
Fulcaster	3 Red.‡	3 Red.
Wyandotte Red		3 Red.
Diamond Bearded		3 Red.
New Monarch		3 Red.
Everitt's High Grade		3 Red.
Golden Prolific		4 Winter.

*Contained some White Wheat.
†Would inspect 3 Red if dry.
‡Would inspect 2 Red if dry.

It will be noticed that the general effects of fertilizing are usually given in establishing a higher grade of wheat.

No. 2 Red is worth about 84¼ cents per bushel in St. Louis, June, 1888.
No. 3 Red " " 80¼ " " " " " " 1888.
No. 4 Winter " " 74¼ " " " " " " 1888.

PROFITS OF FERTILIZING.

VARIETY.	FERTILIZED WITH, PER ACRE.	COST.	GRADE FERTILIZED.	GRADE UNFERTILIZED.	VALUE OF INCREASE.	PROFIT.	LOSS.
Mediterranean Hybrid	200 Ammonium Sulphate	$ 7 00	3 Red.	4 Winter.	$ 6 66	.....	$ 04
Deitz Longberry	275 Sodic Nitrate	8 25	3 Red.	4 Winter.	10 99	$ 2 74	.....
Fulcaster	275 Sodic Nitrate 400 Super-Phosphate	12 25	3 Red.*	3 Red.	9 38	.....	2 87
Early Rice	100 Ammonium Sulphate	3 50	3 Red.	4 Winter.	6 18	2 68	.....
Martin's Amber	150 Sodic Nitrate	3 50	4 Winter.	4 Winter.	3 87	37	.....
Golden Seal	100 Sodic Nitrate	3 00	4 Winter.	4 Winter.	1 26	.....	1 74

*Would have graded 2 Red if dry.

In no other cases did the fertilizers come near paying for the extra expense. The sodic nitrate seems to have given the best results. Ammonium sulphate also did well. At the time the experiments were made it was impossible to get any cotton seed meal. This Fall we will try it thoroughly, and from its composition good results should follow. The latter part of May and first of June we had very heavy beating rains. Up to the time immediately preceding the storm, Golden Prolific was far in the lead of all other varieties in every respect. The rain caused it to rust badly. It may be that next year we will have better luck with it, for it certainly was a most promising variety. When soluble fertilizers like sodic nitrate or ammonium sulphate are used, we advise that only a portion of the amount intended for the land should be applied in the Fall and let the rest be put on in the Spring. They are extremely soluble substances, and have to be applied carefully to avoid loss.

AVERAGE COST OF CULTIVATION.

	COST PER ACRE.
Land deeply plowed and harrowed middle of August	$1 50
Re-plowed and thoroughly horrowed middle of September	1 50
Sowing with drill	50
Cutting and shocking	1 25
Threshing	1 00
Seed worth	1 75
Total average cost	$7 50

It will be easy from the above figures to calculate the profits on the unfertilized varieties.

PEAS.

The soil in which the peas were planted is a sandy loam, sloping slightly to the south. It was heavily manured in 1887 with barn yard manure. The object of the experiment was to determine the comparative yield and earliness of early peas. Numbers are used as a means of representing their comparative yield, 10 being the best.

VARIETY.	SEED OBTAINED FROM	TIME FROM PLANTING TO APPEARANCE OF BLOOM. Days.	TIME FROM PLANTING TO FIRST PICKING. Days.	PRODUCTIVENESS.
American Wonder	Vaughan & Co., Chicago.	33	63	10
Little Gem		35	58	9
Daniel O'Rourke		31	57	9
Lightning		30	54	7½
New Alaska		32	55	7
Premium Gem		34	58	7
Laxton's Alpha		33	58	7
Extra Early Maud S		32	56	6½
Boston Extra Early		33	55	6½
First and Best		32	55	6½
Philadelphia Extra Early		31	55	6½
Blue Peter		37	63	5½
Rural New Yorker	Dept't Agric'e, Wash., D. C.	37	54	6

HORTICULTURE.

Work in this department commenced the second week in March. In this our first report on horticulture we can do little else than give the result of our summer's work. As the experiments we have started are mostly with fruits we can only give the result of the first year's growth and the healthiness of the plants. In the following pages we shall give the success and failure in growth of the different varieties, and if a failure, wherein it lies.

Originators in possession of new fruits and vegetables, and others having chance seedlings or rare varieties of promise are requested to send plants or seeds to the station for testing. We promise you they shall have a fair and impartial trial.

GRAPES.

One hundred and sixty-five varieties were set out last spring. It is not to be expected that all or even a large per cent. of these will prove valuable for this section.

Some will doubtless be of value for amateur collections, where they can receive extra care, while it would not be advisable to grow them in a commercial way. It is our object to give them all a fair trial and recommend those that prove themselves worthy of cultivation. One year is not sufficient to determine this, yet we think it advisable to give to the public the information gained in our first year's work.

Many of the vines were affected with the downy mildew. On July 13 we applied the following remedy:

"Eau Celeste or Blue Water.—Dissolve one pound of sulphate of copper in two or three gallons of warm water; when completely dissolved and the water has cooled add one pint of commercial ammonia; then dilute to twenty-two gallons." Spray the vines with a convenient force pump, using a fine spraying nozzle,

Those desiring further remedies are referred to U. S. Agricultural Report for 1887 (page 328).

The result of the application was quite satisfactory; the mildew was completely checked, no further application being made for six weeks when it appeared again, this time mostly on new foliage and on varieties not previously affected. We do not recommend waiting until the mildew has appeared but to apply the solution as a preventive to all varieties subject to the disease. Below will be found a statement as to the growth and healthiness of each variety during the past summer.

The station vineyard is located on a hillside with a southeast exposure. The soil is loamy with a clay subsoil.

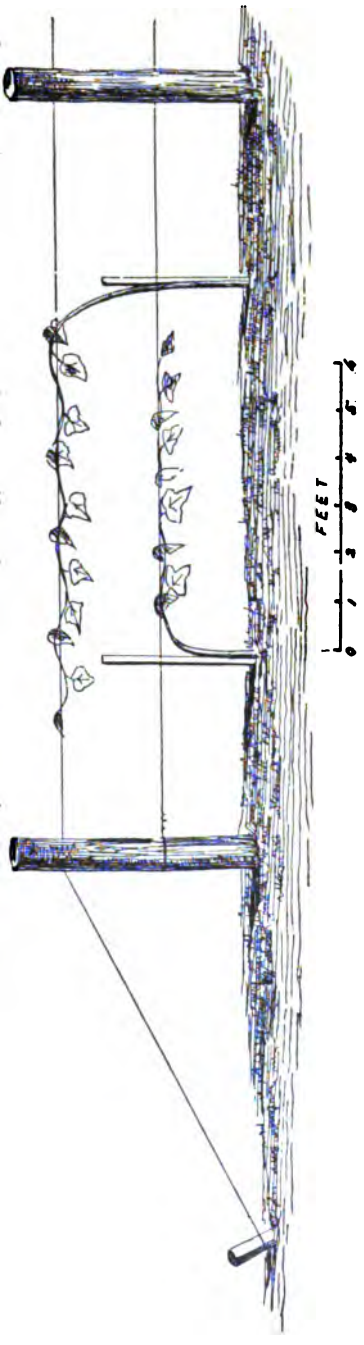
The rows are eight feet apart and the vines are eight feet apart in the rows. The holes were dug eighteen inches square and about the same depth, thus giving the roots ample room to be spread out; the roots were shortened back to from eight to ten inches. Before planting the holes were filled in with top earth so that after planting the vines stood but two or three inches deeper than they originally stood. As soon as the planting was done the trellises were put up. We chose the simple wire trellis as the one best suited to a vineyard with so many varieties with such a wide difference in vigor and growth.

The trellis consists of two wires stretched on common fence posts set sixteen feet apart in the row, the first post being four feet outside of the end vine thus bringing the posts in the row half way between the vines. A lath was stuck in the ground at each vine to support it until it reached the wire. The accompanying cut, representing a section of the trellis, will show clearly the method adopted at the station.

The method of fastening the top wire to a stake prevents the end post being pulled over, by the weight of the vines or heaved out by the action of the frost, much better than the method of bracing.

Pruning.—The subject of pruning is not so complex as many are apt to think; it may be performed either in the fall or spring, fall being preferable; never postpone it until growth has commenced in the spring. The first year cut back the vines to within three buds of the ground; the second year allow two canes to grow and in the fall cut these back to within four or five feet of the ground and on these cut the laterals back to two to four buds. Keep all unhealthy canes trimmed out and allow new ones to grow in their places. Subsequent pruning is to be performed on the same plan as that of the second year; keep the laterals pruned back annually to from two to five buds, depending on the vigor of the vine. Never allow more vine to accumulate than the roots can support.

In the description given below, a growth of less than eight feet is classed as poor, between eight and fifteen is fair and over fifteen is good.



THE LABRUSCA CLASS.

It is from this class and its hybrids that most of our table grapes have originated. The Concord is a good type of this class.

Amanda—Has made a good growth; is free from mildew and has dark green, healthy foliage; looks promising.

Anida—A good growth; mildew appeared July 28 but did little damage.

Beauty—A good growth; mildew appeared September 10.

Brighton—A fair growth; mildew appeared September 10.

Cambridge—A good growth; mildew appeared September 10.

Catawba—A fair growth; mildew appeared September 10.

Challenge—A fair growth; mildew appeared July 13; blue water was applied and the mildew did not appear again sufficient to damage the vines.

Champion—A good growth; mildew appeared July 28, but not sufficient to do much damage.

Concord—This well known variety has made a good growth and our vines have been free from mildew, but in older vineyards in this section it has been affected both by the mildew and black rot.

Cottage—A good growth; mildew appeared September 12

Creveling—A poor growth; mildew appeared September 10.

Diana—A good growth; mildew appeared September 8.

Dracut Amber—A fair growth; mildew appeared September 8.

Early Victor—A fair growth and is free from mildew.

Eaton—A good growth; mildewed slightly after September 15.

Eva—A fair growth and is free from mildew.

Florence—A good growth and is free from mildew.

Hartford—A good growth; mildew appeared July 17.

Hayes—A fair growth; mildew appeared July 13; after the application of blue water it did not appear again.

Iona—A poor growth; mildew appeared September 10.

Iowa Excelsior—A good growth; mildew appeared September 12.

Irving—A poor growth; is free from mildew.

Isabella—Has made a good growth; mildew appeared July 13. One application of blue water was sufficient to keep it in eck up to September 5, when it was quite noticeable again.

Israella—A fair growth; mildew appeared September 8.

Ives—Has made a good growth and is free from mildew.

Lady—A fair growth; mildew appeared July 28, but not sufficient to do much damage.

Martha—A fair growth; mildew appeared to a slight extent on September 8.

Mary Ann—A good growth; mildew appeared September 10.

Mason's Seedling—A good growth; is free from mildew.

Maxatawney—Has made a good growth; mildew had affected the vines to quite an alarming extent by July 13, when blue water was applied, this served to keep it in check until the fifth of September, when the vines were again quite badly affected.

Moore's Diamond—A fair growth; is free from mildew.

Moore's Early—A poor growth; is free from mildew.

New Haven—A poor growth; mildew appeared September 12.

Niagara—This has made the most vigorous growth of any in our collection; mildewed quite badly during the entire season.

North Carolina—A fair growth; mildew appeared September 8.

Northern Muscadine—A fair growth; mildew appeared Juy 17.

Perkins—A good growth; mildew appeared to a slight extent on September 12.

Pocklington—A fair growth; is free from mildew.

Prentiss—A fair growth; mildew appeared to a slight extent on July 13.

Rebecca—A fair growth; mildew appeared quite badly on July 28.

Rentz—A good growth; mildew appeared July 28.

Rochester—A fair growth; mildew appeared July 30.

Telegraph—A good growth; is free from mildew.

Ulster Prolific—A fair growth; is free from mildew.

Venango—Has made a good growth and is free from mildew.

Vergennes—A fair growth; mildew appeared September 10.

Whitehall—A good growth; is free from mildew.

Woodruff Red—A good growth; is free from mildew.

Worden—A fair growth; mildew appears September 10.

Wyoming Red—Has made a fair growth; mildew appeared July 13; blue water was applied and it did not re-appear sufficiently to do any damage.

York Madeira—A good growth; is free from mildew.

THE ÆSTIVALIS CLASS.

This is one of the most important if not *the* most important class of grapes for the southwest.

Bottsi—Has made a poor growth; is free from mildew.

Centennial—A good growth; mildew appeared July 13; blue water was applied and the mildew was not seen again.

Cunningham—Has made a very rank growth and is free from mildew.

Cynthiana—A good growth and is free from mildew.

Devereux—A good growth; mildew appeared September 10.

Elsingburg—A poor growth; mildew appeared July 13.

Eumelan—A good growth; mildew appeared September 10.

Herbemont—A good growth; is free from mildew.

Hermann—A good growth; mildew appeared September 15.

Lenior—A fair growth; mildewed slightly on September 12.

Louisiana—A good growth and is free from mildew.

Neosho—This variety was very feeble from the start, the vines all died early in the season; as it has been grown a great deal in this section and proven itself unsatisfactory and unreliable on account of the rot, we will not try it again.

Norton's Virginia—A good growth; is free from mildew.

Pauline—A poor growth; is free from mildew.

THE RIPARIA CLASS.

Amber—A good growth; mildew appeared September 10.

Bacchus—A good growth; is free from mildew.

Black Pearl—A good growth; mildewed to a slight extent on July 13.

Clinton—A good growth; is free from mildew.

Elvira—A fair growth; is free from mildew.

Etta—A poor growth; mildew appeared September 8.

Faith—A good growth; mildew appeared September 10.

Grein's Golden—A fair growth; mildew appeared September 10.

Humboldt—A fair growth; mildew appeared July 13.

Iron Clad—A good growth; mildew appeared July 28.

Janesville—A good growth; mildew appeared September 12.

Marion—A good growth; mildew appeared to a slight extent on July 20.

Missouri Riesling—A good growth; mildew appeared July 20, but did little damage.

Montifiore—A good growth; on September 10 mildew was noticeable on a few leaves.

Pearl—A good growth; mildew appeared July 13.

Taylor's Bullet—A poor growth; is free from mildew.

Transparent—A fair growth; is free from mildew.

Uhland—A fair growth; mildew appeared July 13.

THE VULPINA OR ROTUNDIFOLIA CLASS.

Flowers—Has made a good growth and is free from mildew.

Scuppernong—A fair growth; is free from mildew.

Thomas—A fair growth; is free from mildew.

THE RUPESTRIS CLASS.

Numbers 60, 62 and 70, as grown by Hermann Jager, of Neosho, Missouri. All have made a good growth, and are perfectly free from mildew.

THE VINIFERA CLASS.

Mission—This variety is a failure as far as tried. None of the vines have made more than eighteen inches growth; the leaves shrivel and dry up in the hot sun, as also the ends of the young shoots. It is free from mildew.

Zinfandel—A fair growth; mildew appeared to a small extent on September 15.

HYBRIDS, CROSSES AND SEEDLINGS NOT DISTINCTLY BELONGING TO ANY OF THE ABOVE CLASSES.

Agawam—Has made a good growth; September 10, mildew appeared to a slight extent.

Alvey—A fair growth; is free from mildew.

Amber Queen—A fair growth; mildew appeared July 13. Blue water was applied, and while it checked the mildew, yet as fast as new leaves were formed they were attacked.

Aminia—This is a fair grower; mildew appeared to a slight extent on July 13.

August Giant—A good growth; mildew appeared September 19.

Autuchon—Is a fair grower and free from mildew.

Berckmans—This variety has made a fair growth and is free from mildew.

Black Defiance—A good growth; mildew appeared September 12.

Black Eagle—A good growth; mildew appeared September 10.

Brant—Is a fair grower and free from mildew.

Canada—Is a poor grower; free from mildew.

Conqueror—A good growth; is free from mildew.

Cornucopia—A good growth; is free from mildew.

Croton—A poor growth; is free from mildew.

Delaware—A fair growth; mildew appeared to a slight extent on September 10.

Duchess—A good growth; mildewed slightly on September 15.

El Dorado—A fair growth and free from mildew.

Empire State—All dead. The wet weather of last spring seems to have been particularly unfavorable for this variety. The vines started several times, but the wet weather, followed by the hot sunshine, seemed to kill them.

Excelsior—A good growth; mildew appeared July 20.

Gazelle—A poor growth; is free from mildew.

Goethe—A good growth; is free from mildew.

Herbert—A good growth; mildew appeared September 12.

Highland—A good growth; mildew appeared to a slight extent on July 20.

Irving—A poor growth; is free from mildew.

Jefferson—A good growth; mildew appeared July 13.

Jessica—A fair growth; mildew appeared July 28.

Lady Washington—A good growth; mildew appeared July 13.

Lindley—A fair growth; mildew appeared July 28.

Massasoit—A good growth and is free from mildew.

Merrimac—A good growth; mildew appeared September 8.

Munson's—A collection of twenty-five varieties of hybrids and seedlings was received from T. V. Munson, of Denison, Texas. As they are new and not disseminated, we will make

no mention of the separate varieties. They all made from fair to good growth, and until wet weather in September, were free from mildew. On September 24, seventeen of the twenty-five varieties were affected by it:

Naomi—A poor growth; mildew appeared July 17.

Noah—A good growth; mildew appeared September 10.

Oriental—A fair grower and free from mildew.

Othello—A good growth; mildew appeared July 13.

Peter Wylie—A poor growth; free from mildew.

Poughkeepsie Red—A good growth; mildew appeared September 10.

Requa—A fair growth; mildew appeared July 13.

Rogers' Hybrids—No. 2 has made a fair growth; mildew appeared September 12.

No. 5—This is a very rank grower and was badly affected with mildew. On July 13 blue water was applied to three out of six vines; on July 17 the three not receiving the application were nearly divested of foliage, the remedy was then applied to these three and the vines continued to grow. On September 10, after two weeks of very rainy weather, nearly all of the new leaves were covered with the mildew.

No. 8—A fair growth; is free from mildew.

No. 11—A fair growth; mildew appeared September 10.

Nos. 13, 14 and 36—These have all made a good growth, and are all affected with mildew, but not quite so badly as No. 5.

Salem—A poor growth; mildew appeared July 13.

Secretary—A fair growth; mildew appeared September 10.

Triumph—A fair growth; mildew appeared September 8.

Waverly—A good growth; mildew appeared September 10.

Wilder—A good growth; mildew appeared September 15.

Wilding—A good growth; mildew appeared September 10.

We see from the above that of the three principal classes Labruscas, Æstivalis and Riparia—the Æstivalis is the least subject to mildew, forty-six per cent. being affected. The mildew also did less damage to the vines of this class that it affected. The Riparia class has the largest per cent. mildewed,

seventy-two per cent. being affected. Of the Labruscas sixty-six per cent. were mildewed.

STRAWBERRIES.

Our collection consists of forty-three varieties. We give here the per cent. of live plants and a few notes on their vigor and health. The soil is a sandy loam:

Atlantic—Seventy-five per cent. alive; is moderately vigorous.

Belmont—Fifty per cent. alive; vigorous.

Bidwell—Eighty per cent. alive, moderately vigorous.

Big Bob—Twenty-three per cent. alive; moderately vigorous.

Bubach No. 5—Eighty-eight per cent. alive; vigorous; produces many runners.

Captain Jack—Thirty-two per cent. alive; not vigorous.

Charles Downing—Sixty-nine per cent. alive; vigorous; produces many runners.

Champion—Fourteen per cent. alive; not vigorous.

Crescent—Eighty-one per cent. alive; vigorous; produces many runners.

Crimson Cluster—Sixty-nine per cent. alive; vigorous; produces many runners.

Crystal City—Fifty-nine per cent. alive; vigorous; produces many runners.

Cumberland Triumph—Thirty per cent. alive; vigorous.

Daniel Boone—Thirty per cent. alive; not vigorous.

Earle—Eighty-eight per cent. alive; vigorous; produces strong and numerous runners.

Early Canada—Sixteen per cent. alive; moderately vigorous.

Glendale—Twenty-nine per cent. alive; not vigorous; produces few runners.

Hart's Minn—Ten per cent. alive; not vigorous.

Henderson—Ten per cent. alive; not vigorous.

James Vick—Eighty-two per cent. alive; not vigorous.

Jersey Queen—Seventy-five per cent. alive; moderately vigorous.

Jessie—Seventy-four per cent. alive; vigorous; produces many runners.

Jewel—Twelve per cent. alive; vigorous; produces few runners.

Jumbo—Seventy-one per cent. alive; not vigorous.

Kentucky—Eighty-four per cent. alive; moderately vigorous.

Legal Tender—Fifty-seven per cent. alive; vigorous.

Mammoth Seedling—Forty-one per cent. alive; moderately vigorous.

Manchester—Fifty-one per cent. alive; vigorous.

May King—Fifty-seven per cent. alive; vigorous; produces many runners.

Monarch—Thirty-six per cent. alive; vigorous.

Mt. Vernon—Eighty-two per cent. alive; vigorous; produces many runners.

Miner—Seven per cent. alive; not vigorous; produces few runners.

Mrs. Garfield—Forty-two per cent. alive; not vigorous.

Old Ironclad—Twenty-four per cent. alive; vigorous; produces few runners.

Parry—Nineteen per cent. alive; vigorous; produces few runners.

Piper—Fifty-eight per cent. alive; moderately vigorous; runners and leaves badly killed out by drouth.

President Lincoln—Sixty-two per cent, alive; vigorous.

Primo—Thirty-two per cent. alive; vigorous.

Prince of Berries—Twenty-one per cent. alive; vigorous.

Sharpless—Thirty-three per cent. alive; vigorous; produces few runners.

Warner—All the original plants are dead.

Wilson—Eighty-five per cent. alive; moderately vigorous.

Windsor Chief—Forty-one per cent. alive; not vigorous.

All but two varieties—Jewell and May King—were more or less affected by the strawberry leaf blight .The Chas. Downing, Earle and Mammoth Seedling were quite badly affected.

BRANCH STATION AT PINE BLUFF.

At this station we have 117 varieties of grapes and forty-two varieties of strawberries. The soil is sandy loam. The grapes are entirely free from mildew.

Below we give a list of the varieties and the character of growth:

THE LABRUSCA CLASS.

VARIETY.	CHARACTER OF GROWTH.	VARIETY.	CHARACTER OF GROWTH.
Amanda	Good	Mary Ann	Good
Beauty	Fair	Mason's Seedling	Good
Cambridge	Fair	Maxatawney	Fair
Catawba	Poor	Moore's Diamond	Good
Cassady	Good	Moore's Early	Poor
Challenge	Good	New Haven	Poor
Champion	Good	Niagara	Good
Concord	Fair	North Carolina	Good
Cottage	Good	Northern Muscadine	Good
Creveling	Fair	Perkins	Good
Diana	Poor	Pocklington	Good
Dracut Amber	Poor	Prentiss	Good
Early Victor	Good	Rentz	Good
Eva	Poor	Rochester	Fair
Hartford	Good	Telegraph	Good
Hayes	Good	Venango	Good
Iona	Poor	Vergennes	Good
Irving	Poor	Whitehall	Good
Isabella	Good	Woodruff Red	Poor
Ives'	Good	Worden	Fair
Lady	Poor	Wyoming Red	Poor
Martha	Fair	York Madeira	Fair

THE ÆSTIVALIS CLASS.

VARIETY.	CHARACTER OF GROWTH.	VARIETY.	CHARACTER OF GROWTH.
Bottsi	Poor	Herbemont	Good
Centennial	Poor	Hermann	Poor
Cunningham	Fair	Lenoir	Good
Cynthiana	Good	Louisiana	Good
Devereux	Fair	Neosho	Poor
Elsingburg	Poor	Norton's Virginia	Good
Eumelan	Poor	Pauline	Poor

THE RIPARIA CLASS.

VARIETY.	CHARACTER OF GROWTH.	VARIETY.	CHARACTER OF GROWTH.
Amber	Fair	Iron Clad	Good
Bacchus	Good	Janesville	Good
Black Pearl	Poor	Marion	Fair
Clinton	Fair	Missouri Riesling	Poor
Elvira	Good	Montifior	Good
Etta	Good	Pearl	Good
Faith	Good	Transparent	Fair
Grein's Golden	Poor	Uhland	Fair
Humboldt	Good		

HYBRIDS, CROSSES AND SEEDLINGS.

VARIETY.	CHARACTER OF GROWTH.	VARIETY.	CHARACTER OF GROWTH.
Agawam	Good	Herbert	Good
Alvey	Fair	Highland	Fair
Amber Queen	Fair	Jefferson	Fair
Aminia	Good	Jessica	Dead
August Giant	Good	Lindley	Good
Autuchon	Fair	Massasoit	Poor

HYBRIDS, GROSSES AND SEEDLINGS.—*Continued.*

VARIETY	CHARACTER OF GROWTH.	VARIETY.	CHARACTER OF GROWTH.
Barry	Fair	Merrimac	Fair
Black Defiance	Poor	Naomi	Poor
Black Eagle	Fair	Noah	Good
Brant	Poor	Norwood	Poor
Brighton	Fair	Oriental	Good
Canada	Fair	Othello	Fair
Conqueror	Fair	Peter Wylie	Good
Cornucopia	Good	Requa	Fair
Croton	Poor	Rogers No. 9	Good
Delaware	Poor	Salem	Fair
Duchess	Good	Secretary	Fair
Eldorado	Good	Triumph	Fair
Empire State	Poor	Waverly	Fair
Excelsior	Poor	Wilder	Good
Goethe	Fair	Wilding	Poor

STRAWBERRIES.

Atlantic.—Fifty per cent. alive; vigorous.

Belmont. –All dead.

Bidwell.—Twenty-eight per cent. alive; vigorous; has produced but few runners.

Big Bob.—Eleven per cent. alive; not vigorous; produced few runners.

Bubach No. 5.—Seventy-two per cent. alive; very vigorous; produced many runners.

Captain Jack—Twenty-one per cent. alive; not vigorous; produces few runners.

Charles Downing—Five per cent. alive; vigorous.

Champion—Six per cent. alive; not vigorous,

Crescent—Eighty-two per cent. alive; very vigorous; produced many runners.

Crimson Cluster—Seventy-three per cent. alive; vigorous.

Crystal City—Twenty-eight per cent. alive; vigorous.

Cumberland Triumph—All dead.

Daniel Boone—Nineteen per cent. alive; not vigorous; produced few runners.

Early Canada—Twenty-one per cent. alive; not vigorous.

Finch Seedling—Eleven per cent. alive; not vigorous.

Glendale—Thirty-three per cent. alive; not vigorous; produced few runners.

Hart's Minn—Twenty-five per cent. alive; not vigorous.

Henderson—Ten per cent. alive; vigorous.

James Vick—Twenty-nine per cent. alive; not vigorous.

Jersey Queen—Fifty-eight per cent. alive; vigorous.

Jessie—Sixty-five per cent alive; very vigorous; produced many runners.

Jewell—Six per cent. alive; vigorous.

Jumbo—Forty-seven per cent. alive; not vigorous.

Kentucky—Thirty-eight per cent. alive; vigorous.

Legal Tender—Fifty per cent. alive; vigorous; produced few runners.

Mammoth Seedling—Forty per cent. alive; not vigorous.

Manchester—All dead.

May King—Forty per cent. alive; vigorous.

Miner—Fifty per cent. alive; vigorous; produced large, strong runners.

Monarch—Twelve per cent, alive; vigorous; produced few runners.

Mt. Vernon—Sixty-eight per cent. alive; very vigorous; produced many runners.

Mrs. Garfield—Fifty-two per cent. alive; vigorous.

Old Ironclad—Twenty-two per cent. alive; not vigorous.

Parry—Nine per cent. alive; vigorous; produced few runners.

Piper—Ninety-four per cent. alive; during dry weather in August many of the leaves and runners dried up.

President Lincoln—Twenty-two per cent. alive; not vigorous.

Primo—Five per cent. alive; not vigorous.

Prince of Berries—Eleven per cent. alive; not vigorous; has made few runners.

Sharpless—All dead.

Warner—All dead.

Wilson—Seventy-eight per cent. alive; vigorous.

Windsor Chief—Six per cent. alive; vigorous.

All but the Legal Tender, May King and Ironclad were more or less affected by the leaf blight; the Charles Downing was very much injured by it.

HORTICULTURE.

We give here the names of the different varieties of fruit growing on the Experiment Station grounds, together with the names of the parties furnishing them:

Received of Gill and Vincenheller, of Springdale, Arkansas, spring of 1888:

Turner Raspberry,
Gregg Raspberry,
Russian Mulberry.
Kittatinny Blackberry,
Blackman's Plum,

Received of T. V. Munson, of Denison, Texas, spring of 1888:

APPLES.

Steward,
Yellow Forest.
Gano's Red,
Shirley's Keeper.

PEACHES.

Lady Ingold,
Scruggs,
Gen. Grant.
Miss Lula,
Barnes,
Bishops Early.

PEARS.

Bruce.
Gross Blanquet.

Received of James B. Wild and Bros., of Sarcoxie, Missouri, spring of 1888:

APPLES.

Alexander,
Borsdoffar,
Gill's Beauty,
Mann,
Occident,
Plumb's Cider,
Stump,
Tetofsky,
Wolf River,
Salome,
Chiman Pippin,
Gideon's Best.
Brightwater,
Hass,
Langford Seedling,
Moore's Ruby,
Paragon,
Red Bietigheimer,
Shackelford,
York Imperial,
Toy,
Winter May,
Northwest Greening.

PEARS.

Early Harvest,
Bartlett.
Louis Bde. Jersey,
Duchess.

PEACHES.

Jennie Worthen,
Peen-to,
Andrew's Mammoth,
Gen. Lee.
Mrs. Brett,
Tong-pa,
14 oz. Cling,

NECTARINES.

Early Violet, New White.
Victoria.

APRICOTS.

Alberge, Breda.
Moorepark.

JAPAN PLUMS.

Prunus Simoni, Satsuma,
Botan, Botankio,
Kelsey. Ogon.

Received of R. D. McGeehon, of Atlantic, Iowa, spring of 1888:

RASPBERRIES.

Turner, Cuthbert,
Marlboro, Souhegan,
Ohio, Johnson's Sweet,
Shaffer, Thack,
Tyler.

CURRANTS.

Cherry, Victoria,
White Grape, Red Dutch.
Fay's Prolific.

BLACKBERRIES.

Stone, Britton,
Taylor's Prolific, Snyder.
Early Harvest.

DEWBERRIES.

Lucretia. Windom.

GOOSEBERRIES.

Houghton Seedling. Downing.

Received of Iowa Agricultural College, spring of 1888:

APPLES.

Red Stettin, Cross,
Boiken, Sandy Glass,
Apart, Himbeer,
Thaler, Antonooka,
Ukraine, Blackwood,
Lead, Good Peasant,
Sintrer, Cardinal Cellina,
Antonooka (Vilne), Bagdanoff,
Great Mogul, Yellow Transparent,
Yellow Reinette, Red Aport,
Aport Seedling, Scott's Winter,
Red Queen, Winter Streipling,
Borovinka, Grandmother.
Longfield.

PLUMS.

Rollingstone,	Moldanka,
Mount Pekin,	Desoto,
†Hungarian No. 1,	Wolf,
Hungarian No. 2,	Maquoketa,
Russian No. 3,	Orel No. 19,
Black Prune.	Orel No. 20.

PEARS.

Bessemianka,	No. 416,
Lemon,	Peffer No.,
Kurskaya,	No. 439,
Long Stem,	No. 385,
Gakovska.	No. 391.

CHERRIES.

Sklanka,	Russian No. 62,
Lutooka,	Mount Ordinary,
Large Montmorency.	Brusseler Braine,
Duchess de Angeline,	Abbess.
Cerise de Ostheim.	

†When numbers are given they correspond to the importation numbers of the Iowa Agricultural College.

SHRUBS.

Tamarix Amurensis,	Spirea Van Houteii,
Syringa or Mock Orange,	Hypericum,
Hypericum Hercinum,	Spirea Prunifolia,
Spirea Hypericafolia,	Rosa Rugosa.
Aleagnus Augustifolia.	

We also have the following apple trees in orchard three years old. Trees received of J. B. Gill, of Springdale, Arkansas, spring of 1886:

Early Harvest,	Willow Twig,
White Winter,	Rome Beauty,
Horse,	Arkansas Red,
Sweet Bough,	Maiden's Blush,
Rambo,	Kossuth,
R. W. Romanite,	Red Astrachan,
Stark,	Ben Davis,
Limber Twig,	Wine Sap,
Stevensoil's Pippin,	Jenniton,
Mammoth Pippin,	Woolsey's Seedling,
Grindstone,	Pa Cider,
Arkansas Black,	Hatchers' Seedling,
Mammoth Black Twig,	Shockley,
Shannon Pippin,	Yellow Bellflower,
Buckingham.	Lanier.

POTATOES.

Our experimental work in potatoes has been carried on at Texarkana and Fayetteville. It has been conduted with a view to determine the varieties best suited to the different sections of the State; the diverse effects of fertilizers and the quality of potatoes grown with and without chemical and barn yard manure. Our potatoes were planted with an Aspinwall Potato Planter—an implement that does good work. They were cut medium. The soil at Fayetteville is a sandy loam; at Texarkana it is more sandy.

The Fayetteville potatoes were grown in new land; that at Texarkana had been previously cultivated for several years, the crop having usually been cotton. The yield was larger at Fayetteville, but our soil was richer. The varieties that gave the best results differ at the two places. We do not wish these, our first year's results, to be taken as determining absolutely the variety of potatoes to cultivate, but they may be taken as a tolerably good indication. Fertilizing potatoes has not as yet been extensively practiced in Arkansas, but when we can so obviously make a better profit on our work by their employment, it would be advisable for farmers to try them if even they commence on a small scale. It is obvious that, with the land well prepared and properly manured, we can get big results, and what we can do the other farmers in the State can do also.

Beauty of Hebron.

American Giant.

Early Ohio.

Alexander's Prolific.

White Elephant.

Early Harvest.

Chicago Market.

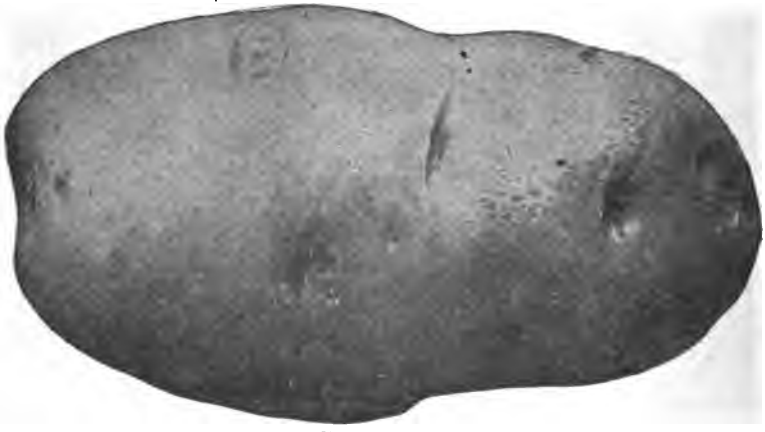
Vick's Extra Early.

White Star.

Early Telephone.

Thorburn.

Clark's No. 1.



Early Albino.

Lee's Favorite.

NOTES ON VARIETIES.

Early Albino. Long cylindrical, somewhat flattened. Native of Vermont.

Empire State. Tubers cylindrical, smooth, white.

Charles Downing. An oval tuber, white and smooth skinned.

Lee's Favorite. Similar in shape to Early Rose, light in color, size large, skin smooth, grows close and shallow in hill. Early variety.

Pearl of Savoy. This variety is a cross between Clark's No. 1 and Early Vermont; tubers generally spherical.

Early Maine. A smooth skinned variety; tubers long, cylindrical, color white.

Vick's Early. A good variety; cylindrical in shape, cooks well.

Clark's No. 1. Tubers large, spherical; similar in appearance to Early Rose, skin white; originated in New Hampshire. Early variety.

Beauty of Hebron. Skin smooth, slight pink tinge, turning white. A well known standard variety.

Chicago Market. Tubers large, oval or round, form clusters in the hills, flesh white.

Early Harvest. This is an early variety, similar to the Early Rose.

Early Ohio. Tubers spherical to oval. Early variety.

White Elephant. White skin, long, cylindrical. Late.

White Star. Tubers oblong, large; a cross between the Excelsior and White Peachblow.

Alexander's Prolific. Skin white, well covered with rough netting, tubers long, good size eyes, medium depth. Late.

Thorburn. A self seedling of the Beauty of Hebron; tubers spherical to oval, skin yellow. Dry and floury when cooked, with compact and firm grain. Early.

Early Telephone. Tubers medium, white; cross between Snowflake and Peachblow. Good keeper.

American Giant. Tubers very large, long, tapering, white. About two weeks later than Early Rose.

Queen of the Valley. Tubers large, color pink, shape long, flattened at the end.

Snowflake. This variety is too well known to need description

Hall's Early Peachblow. Tubers spherical, white, pink eyes, medium size.

Dakota Red. Tubers long color reddish, cylindrical, eyes medium, flesh white. Late.

Burbank. This old variety is well known to all.

Sunlit Star. Early variety; skin clouded, with rose color.

Rose's Beauty of Beauties. A Peachblow seedling; large size, pure white flesh. Medium variety.

Dictator. Medium variety; good quality, nearly round in shape.

Rural Blush. Flesh slightly tinged with pink, blush skin. Medium variety.

Rose's Wild.

Rose's New Giant. Oblong, flattened, large size, white skin and flesh, shallow eyes. Late.

Mammoth O. K. Prolific. White, spherical, medium size.

Triumph. Tubers long, partly flattened, light colored, smooth, medium size.

Home Comfort.

Peerless.

Our seed were obtained from: J. C. Vaughan & Co., Chicago, Ill.; Thorburn & Co., New York, N. Y.; Peter Henderson, New York, N. Y.; St. Louis Plant Seed Co.; Badger Seed Farm, Wisconsin.

The following tables show the yield of unfertilized potatoes at Fayetteville and Texarkana.

UNFERTILIZED—FAYETTEVILLE.

DATE OF PLANTING.	VARIETY.	DATE OF BLOOMING.	DATE OF DIGGING.	YIELD BU. LARGE POTATO'S PER ACRE	YIELD BU. SMALL POTATO'S PER ACRE	Weight, lbs. pr. bu.
March 19..	Mammoth O K Prolific.....	June 2	July 27	138	12	59
19..	Vick's Early	May 24	25	75 1-6	8 1-2	59
19..	Beauty of Hebron.....	24	21	75 1-12	22 1-4	56
20..	Dictator	June 2	27	159 1-2	15 1-2	56
20..	Rural Blush	May 28	27	179 7-8	16 1-8	61
20..	Triumph	....	13	51 1-2	25 1-2	57
20..	Early Harvest	May 28	20	77 1-6	12 1-2	58
20..	Thorburn	20	27	96 2-3	20	58
20..	Lee's Favorite.....	....	20	78 5-6	11 1-2	60
20..	White Star.....	....	27	128	6	56
20..	Snowflake.....	....	27	105	.....	54
20..	Empire State	28	27	166 2-3	.....	58
20..	American Giant.....	24	27	156	12	54
20..	Dakota Red.....	24	27	154 2-3	.....	58
20..	Early Telephone.....	24	27	75 2-3	4 1-2	60
20..	Hall's Early Peachblow....	24	27	87 3-4	5 1-4	60
20 .	Pearl of Savoy.....	24	13	61 5-12	20	57
20..	Queen of the Valley	24	27	94 3-4	4 1-4	60
20..	Chicago Market.....	24	27	132	3 1-2	59
20..	Alexander's Prolific	24	27	128 1-2	16	60
22..	Early Albino	24	13	91 2-3	16 1-2	58
22..	White Elephant.	28	11	80 1-2	19 1-2	57
22..	Early Maine.....	23	27	142 1-6	9 1-2	62
22..	Sunlit Star	24	27	75 5-24	8 1-8	61
22..	Home Comfort	24	27	116 7-12	4 1-4	62
22..	Rose's New Giant.....	28	27	70 5-6	10	58
22..	Rose's Beauty of Beauties	28	27	104 1-2	8	58
22..	Rose's Wild Rose.....	24	27	120 1-6	4	56
22..	Early Ohio.....	28	27	118 5-6	14 1-2	58
22..	Charles Downing	24	11	56	14	56
22..	Burbank	24	27	84 1-2	18	59
22..	Clark's No. 1.....	24	27	53	10	60
22..	Peerless			77	20	59

UNFERTILIZED—TEXARKANA.

VARIETIES.	DATE OF BLOOMING.	TOPS DIED.	YIELD BU. LARGE POTATOES.	YIELD BU. MEDIUM.	YIELD BU. SMALL.	TOTAL BU. PER ACRE.
Early Albino	May 28	June 10	41	20	11	72
Rural Blush	29	22	22	11	6	39
Rose's Wild	27	30	55	14	4	73
Queen of the Valley	26	28	12	11	6	28
Alexander's Prolific	June 2	27	20	12	16	48
Beauty of Hebron	May 31	July 1	55	30	15	100
Sunlit Star	June 6	1	41	25	22	88
Home Comfort	June 4	2	51	32	12	95
Vick's Early	May 30	June 24	23	16	11	50
White Elephant	June 3	28	45	15	12	72
Rose's New Giant	5	30	46	26	10	82
O K Mammoth Prolific	8	29	53	2	7	88
American Giant	4	July 1	61	21	13	95
Dictator	7	2	58	27	10	95
Chicago Market	8	June 27	63	33	22	118
Dakota Red	9	26	66	33	15	114
Early Telephone	7	23	64	26	10	100
Early Ohio	May 31	25	32	15	5	52
Early Maine	28	23	79	31	30	140
Thorburn	June 4	28	54	31	16	101
Charles Downing	May 31	25	56	29	14	99
Triumph	29	July 2	86	44	13	143
White Star	June 7	1	58	37	16	111
Snowflake	May 31	3	57	33	20	110
Rose's Beauty of Beauties	June 4	3	68	47	31	146
Empire State	2	June 30	54	24	17	95
Hall's Peachblow	May 28	29	38	17	10	65
Burbank	June 4	27	24		7	40
Lee's Favorite	6	28	37	28	25	90
Pearl of Savoy	4	26	17	23	15	55
Clark's No. 1	May 28	26	47	28	16	91
Early Harvest	June 1	26	30	19	11	60

Planted March 28. Dug July 6.

The following experiments in fertilizing were made with the Dakota Red potato, all plats being fertilized and planted the same date:

FERTILIZERS USED PER ACRE.	YIELD LARGE BUS. PER ACRE	YIELD SMALL,	TOTAL BUS. PER ACRE	COST OF FERTILIZER PER ACRE	VALUE OF INCR'SE AT 25C PER BUSHEL.	PROFIT.	LOSS.
400 lbs. Ammonia Salts 300 lbs. Kainit 300 lbs. Superphosph'te	254½	21	275½	$18 80	$31 75	$12 95	.....
500 lbs Nitrate Soda 300 lbs. Superphosph'te 300 lbs. Kainit	229¾	26½	256¼	19 80	26 75	6 95	.....
10 tons Barnyard Manure 300 lbs. Superphosph'te 500 lbs. Nitrate Soda	225	23	248	23 00*	24 75	1 75	.....
400 lbs. Cotton Seed Meal 300 lbs. Kainit 300 lbs. Superphosph'te	211¼	20¼	231½	7 40	20 75	13 35	.....
200 lbs. Chloride Potash	176½	13½	190	4 50	10 50	6 00	.....
10 tons Barnyard Manure 300 lbs. Superphosph'te	171	15½	186½	8 00*	9 50	1 50	.....
10 tons Barnyard Manure	160¾	17½	178¼	5 00*	7 75	2 75	.....
300 lbs. Cotton Seed Meal	150	10¼	160¼	2 60	2 75	15	.....
300 lbs. Superphosph'te 300 lbs. Kainit	143½	16¾	160	4 80	2 70	.....	$2 10
300 lbs. Superphosphate	137¼	15¼	152½	3 00	1 00	.....	2 00
400 lbs. Wood Ashes	131½	16½	148	2 00	Nothing	.....	2 00
Nothing	134¼	14¼	148½	.....	.....	.....	.....
Nothing	132	13¾	145¾	.....	.....	.....	.....

* The value of Barnyard Manure varies with the locality, and every farmer must calculate for himself what it will cost him.

The experiments with fertilizers on varieties were made with a view to determine their relationship to experiments made with one variety. They will be noticed to have given nearly similar results. There are, however, some slight differences, but not of a sufficient importance to vitiate the application of the one variety results to all.

VARIETY.	FERTILIZERS USED.	YIELD BUS. LARGE.	YIELD BUS. SMALL.	TOTAL BUS. PER ACRE	FERTILIZERS ON ½ PLAT USED.	YIELD BUS. LARGE.	YIELD BUS. SMALL.	TOTAL BUS. PER ACRE	COST OF FERTILIZERS	INC. BU. FERT. OVER UNFERTILIZED.	VALUE OF INC. AT 25C. PER BU.	PROFIT PER ACRE.	LOSS PER ACRE.
Mammoth O K Prolific	5 tons Farmyard Manure	150	17	167	Nothing	138	12	150	$ 2 50	17	$ 4 25	$ 1 75	.....
Vick's Early	10 tons Farmy'd Man. 200 lbs. Superphosph'te	120	5	125	Nothing	76 1-6	8 1-2	84 2-3	8 00	40 1-3	10 08	2 08	.....
Beauty of Hebron	5 tons Farmyard Manure	86 3-8	28 1-8	115 1-2	Nothing	75 1-4	22 1-4	98 1-3	2 50	17 1-6	4 30	1 80	.....
Dictator	500 lbs. Nitrate Soda 300 lbs. Superphosph'te 300 lbs. Kainit	223 1-6	21 1-2	244 2-3	Nothing	159 1-2	15 1-2	175	19 80	69 2-3	17 70	.....	$ 2 10
Rural Blush	400 lbs. Ammonia Salts 300 lbs. Kainit 300 lbs. Superphosph'te	260	20	280	Nothing	179 7-8	16 1-8	196	18 80	84	21 00	2 20	.....
Triumph	10 tons Farmyard Manure	79 1-6	25 1-2	104 2-3	Nothing	51 1-2	25 1-2	77	5 00	27 2-3	6 90	1 90	.....
Early Harvest	300 lbs. Superphosph'te 300 lbs. Kainit	96 5-9	22 3-4	119 1-6	Nothing	77 1-6	12 1-2	89 2-3	6 80	19 1-2	4 87	.....	1 93
Thorburn	300 lbs. Superphosphate	119 2-3	15	134 2-3	Nothing	96 2-3	20	116 2-3	3 00	18	4 50	1 50	.....
Lee's Favorite	400 lbs. Cot. Seed Meal 300 lbs. Kainit 300 lbs. Superphosph'te	115 7-12	21 1-4	136 5-6	Nothing	78 5-6	11 1-2	90 1-3	7 40	46 1-2	11 62	4 22	.....
White Star	10 tons Farmy'd Man. 300 lbs. Superphosph'te 500 lbs. Nitrate Soda	197 1-4	8 3-4	200	Nothing	128	6	134	23 00	66	16 50	.....	6 50
Snowflake	400 lbs. Wood Ashes	95 1-2	12 1-2	108	Nothing	93 1-2	11 1-2	105	2 00	.....	.....	.....	2 00
Empire State	300 lbs. Cotton Seed Meal	179 1-2	20 1-2	200	Nothing	150	16 2-3	166 2-3	1 95	23 1-3	5 83	3 88	.....
American Giant	400 lbs. Wood Ashes 200 lbs. Sulphate Soda	157	18	175	Nothing	156	12	168	.....	7	1 75	.....	.....
Dakota Red	200 lbs. Chloride Potash	179 1-4	12 3-4	192	Nothing	143	11 2-3	154 2-3	4 50	37 1-3	9 33	4 83	.....

VALUE OF FERTILIZERS PER TON { Farmyard Manure varies. Wood Ashes.....$ 10 00 | Cotton Seed Meal.....$ 13 00 Kainit ..... 12 00 | Chloride of Potash .....$ 45 00 Superphosphate..... 20 00 | Ammonium Sulphate.....$ 70 00 Nitrate of Soda..... 60 00

Since the percentage of starch determines the value of the potato, we have made a series of analyses of our Fayetteville and Texarkana varieties, and the results will be found below:

VARIETY.	PER CENT OF STARCH WHEN GROWN AT FAYETTEVILLE.	PER CENT OF STARCH WHEN GROWN AT TEXARKANA.	PER CENT OF WATER WHEN GROWN AT FAYETTEVILLE.	PER CENT OF WATER WHEN GROWN AT TEXARKANA.
Empire State	70.03	67.26	13.76	11.61
Early Albino	72.80	68.51	11.80	11.24
Rose's Beauty of Beauties	.....	66.70	.....	11.99
Alexander's Prolific	.....	70.28	.....	12.65
White Star	71.60	67.75	13.61	12.12
Dictator	.....	69.35	.....	13.40
Rose's Wild	.....	70.35	.....	11.96
Beauty of Hebron	72.49	71.32	14.04	11.45
Sunlit Star	.....	70.57	.....	12.15
Charles Downing	71.67	71.81	11.76	11.88
Early Harvest	71.41	68.36	13.30	11.70
Clarke's No. 1	.....	69.66	.....	12.05
Early Telephone	72.76	66.58	12.78	11.99
Pearl of Savoy	69.79	69.63	10.41	13.28
Dakota Red	.....	70.09	.....	12.57
Lee's Favorite	67.76	70.99	12.21	12.12
Hall's Peachblow	.....	69.00	.....	12.81
Vick's Early	72.21	72.24	13.81	11.33
Rose's New Giant	.....	68.43	.....	13.18
Queen of the Valley	.....	66.29	.....	13.60
Rural Blush	72.44	67.67	13.91	12.61
American Giant	68.11	69.36	14.05	12.58
Chicago Market	.....	68.70	.....	12.25
Mammoth O K Prolific	.....	69.52	.....	13.13
Home Comfort	.....	72.95	.....	13.02
Thorburn	72.83	66.53	11.94	12.44
White Elephant	70.42	72.49	12.05	11.01
Triumph	69.21	69.82	12.88	12.93
Early Ohio	.....	70.06	.....	12.00
Snowflake	67.56	72.24	12.56	12.64
Early Maine	.....	68.13	.....	12.46
Burbank	.....	72.01	.....	12.27

The foregoing table is self-explanatory, as it shows which variety in each location yielded the largest percentage of starch.

Method of Analysis.

The potatoes were washed, cut into thin slices and dried in the air. These air dried slices were ground in a mortar and sifted through cloth. The moisture was determined by heating two grams in an oven, at 100°, or until the weight was constant.

Estimation of Starch.

Two grams of finely pulverized potato were boiled for three hours with 100cc of a two per cent. solution of Hyduchlone, and (according to Sachsse) a small portion was tested with Iodine to show the complete conversion of starch. The whole was filtered, and washed with hot water until the washings gave no reaction with Fehlings' test. The filtrate was made up to 250cc (or some convenient volume) and an aliquot part (1-10) used for the estimation of dextrose.

60cc of alkaline copper solution (prepared according to Allihu) was heated just to boiling, in a beaker or porcelain dish of about 300cc capacity. To the boiling solution 25cc of the dextrose solution (which had been nearly but not quite neutralized with sodic hydrate) are added, and the heating further continued until boiling begins again. After the reduced copper suboxide has settled the estimation of dextrose is continued according to Collier. That is the suboxide, is washed and decanted until the washings are nearly neutral. The washings are filtered, taking care to bring as little of the suboxide as possible on to the filter.

Sorghum Analysis—Peter Collier, pp. 473.

The suboxide of copper is dissolved in an acid solution of Ferrik alum and titrated with permanganate. A solution of permanganate of one-fourth the strength which Collier mentions gives, in this case, better results. The weight of the dextrose multiplied by nine gives the weight of the starch.

SORGHUM.

The recent work in Kansas on this subject has awakened an increased interest in the sugar industry. It is claimed that by what is known as the diffusion process a largely increased percentage of sugar is extracted from the cane. Heretofore the difficulty of obtaining the sugar remaining in the bagasse has impeded the development of this industry; fortunately however, it is asserted, and the assertions are backed up by the formation of large corporations, that this impediment has been eliminated. In Kansas we have at the present day several

large companies employing their capital in this direction. From our observation we see no reason why Arkansas should not also enter the field as a sugar producing State. Land can be had cheaply and sorghum apparently grows as well if not better than in Kansas. With these ends in view we have made a series of *preliminary* observations, to determine the percentage of sucrose in cane grown in Arkansas, the effect of fertilizers on the sugar content, and the selection of varieties and adoption of methods by means of which the sugar content might be increased. This work is naturally slow and will take considerable time and patience to accomplish our ends. The amount of laboratory work necessary is enormous, the analytical determinations running up into the thousands. We have so far made experiments with some sixty varieties of sorghum obtained from different parts of the world.

Mode of Planting, Etc.

The soil was a sandy loam, it was well plowed and harrowed, time being taken to get the soil well pulverized. This is a most important point in the cultivation of sorghum, for it renders subsequent work easier. Especial care must be taken to prevent weeds from getting any start whatever of the crop. The seed may be planted in either hills or drills; when planted in hills it gives a better opportunity for cultivation. On very strong land it may be drilled, the stalks being four inches apart in the drill, and the drills three feet apart. Either machine or hand planting may be adopted. Usually rows four feet apart and seed ten inches apart will be found advisable. After planting the great enemy to sorghum, viz: weeds, have to be kept in constant subjection and this can only be accomplished by continual cultivation. Sorghum is more delicate than corn and consequently requires more care; otherwise, subsequent cultivation is identical. We planted our seed on the following dates:

April 17. Early Amber, Early Orange.
" 18. Kansas Orange, Link's Hybrid, Golden Rod, New Orange, Texas Honey Drip, White Indian, Red Liberian, Red Top, Club Head.
April 26. Hybrids numbers 1 to 26 inclusive.
" 27. Club Head A. T., Pierces' Cross, Honduras from La., Golden Reed from Ga.; Little Shanch from Mo.; Silver Top, (Brown Co.) Texas; Late Orange, N. J.; Honey Drip, Texas; Honey Cane, Texas; White Indian; White Mammoth, Ga.; Red Top, Tex.; Early Orange, Kas.; Link's Hyb, Ft. Scott;

Early Amber, Ft. Scott; Kansas Orange, New Orange, White Mammoth, Kas.; New Cane, Cent. America; White Amber, Neb.; Butcher's Hyb, Iowa; Goose Neck, Tex.; Red Top, Tex.; Envamar, Honey Dew, Ind.; Kaffir Corn, Yellow Doura.

May 2. Medium Orange, Ill.; Russells New, Mo.; Honey Dew, Ind.; Early Orange, S. C.; Pierces' Early Golden, Me.; Waubauser, Kas.; Chinese Cane, France; Sorghum, (?) Tex.

The following explanation will illustrate the various stages of development:

STAGES.

1. About one week before the opening of panicle.
2. Immediately before opening of panicle.
3. Panicle just appearing.
4. Panicle two-thirds out.
5. Panicle entirely out; no stem above upper leaf.
6. Panicle beginning to bloom on top.
7. Flowers all out; stamers beginning to drop.
8. Seed well set.
9. Seed entering the milky state.
10. Seed becoming doughy.
11. Seed doughy, becoming dry.
12. Seed almost dry, easily crushed.
13. Seed dry, easily split.
14. Sucker in bloom.
15. Sucker seed in milk.
16. Sucker seed in dough.
17. Sucker seed hard.
18. After sucker seed hard.

By the sucker is meant the offshoot from the upper joints of the parent stalk upon which panicles will mature.

Method of Analysis.

The analytical processes adopted for the examination of the cane were identical with those of Collier (vide Sorghum pp 471, et seq). In the polarizations we used a new Solid Scheibler instrument which we found to work well, the customary methods being employed. The total solids by Brix it will be noticed agreed well with those made by the direct process. We intend to publish a discussion of these Brix and direct determination results in "Agricultural Science."

The results obtained are tabulated as follows:

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per Cent. of Juice	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Early Amber	July 31	10	46	38	17	44.7	.....	1.93	14.55	.....	1.055	27
" "	Aug. 6	11	42	32	12.6	39.3	11.59	1.63	15.02	.....	1.060	57
" "	Aug. 10	12	31	24	13.6	56.6	11.03	1.73	14.52	.....	1.054	91
" "	Aug. 15	13	40	32	18	56.2	9.40	.....	15.45	.....	1.064	46a
" "	Sept. 5	16	57	47	22.1	47.2	14.10	.....	.....	17.2	1.069	52b
" "	Sept. 11	18	65	54	30.4	56.3	14.92	1.28	18.71	19.2	1.073	21c
Golden Rod	July 31	13	26	19	17.0	.....	.....	1.93	14.55	.....	1.055	27
" "	Aug. 7	14	64	46	22.4	48.7	8.11	1.50	13.22	.....	1.052	70
" "	Aug. 13	15	36	28	7.6	27.1	5.57	1.40	12.01	.....	1.047	8a
" "	Aug. 23	16	45	30	10.75	35.8	4.56	1.74	9.47	.....	1.041	● 80a
" "	Sept. 5	18	56	39	19.6	50.3	7.99	.....	.....	13.0	1.053	56b
Texas Honey Drip	Aug. 2	9	77	60	20.1	33.5	8.25	.....	12.97	.....	1.053	39
" " "	Aug. 8	9	36	29	16.75	55.2	9.05	4.10	14.20	.....	1.059	.75
" " "	Aug. 10	9	32	23	15.2	66.1	7.31	2.56	11.36	.....	1.047	92
" " "	Aug. 24	11	40	29	13.6	46.9	4.38	3.70	9.25	.....	1.043	82a
" " "	Aug. 27	12	59	36	21.2	58.8	6.74	2.31	10.96	.....	1.043	93a
" " "	Sept. 5	16	88	57	30.75	53.9	6.03	.....	.....	11.4	1.045	58b
" " "	Sept. 10	17	89	59	36.5	61.8	8.82	3.00	13.62	13.4	1.053	5c
" " "	Sept. 10	17	64	46	24.75	53.8	12.57	2.24	16.81	17.3	1.069	16c
" " "	Sept. 19	18	78	55	29.6	53.8	11.87	1.70	15.13	16.1	1.067	51c
New Orange	Aug. 4	8	29	20	.....	.....	.....	.....	.....	.....	.....	51
" "	Aug. 15	9	58	39	9.2	23.6	8.06	.....	13.19	.....	1.055	45a
" "	Aug. 23	10	41	29	16.6	57.2	9.54	2.16	13.95	.....	1.058	81a
" "	Aug. 27	11	38	25	13.6	54.4	9.72	2.20	10.31	.....	1.055	95a
" "	Sept. 5	15	64	44	23	52	11.37	.....	.....	16.0	1.062	57b
" "	Sept. 10	16	89	59	38.75	65	9.30	2.40	13.74	14.3	1.059	6c
" "	Sept. 17	16	65	46	24.6	43	12.77	1.88	15.82	16.8	1.071	50c
" "	Sept. 21	16	78	54	31.6	58	12.65	.....	17.50	18.5	1.075	86c
" "	Sept. 28	17	70	54	26	48	13.21	3.26	18.29	19.2	1.076	29d
White Idia	July 4	8	40	31	.....	.....	.....	.....	.....	.....	.....	53
" "	Aug. 24	11	51	40	22.6	56	4.03	2.27	9.58	.....	1.038	83a
" "	Sept. 5	16	69	53	30	56	.....	.....	.....	.....	.....	59b

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr. ct. total Solids direct meth.	Pr. ct. totat Solids by Brix.	Specific Gravity.	Analy's Number
White Idia	Sept. 10	17	100	76	45	59	6.90	3.19	10.71	11.4	1.046	4c
" "	Sept. 11	17	76	57	29.75	52	9.61	3.22	13.80	14.2	1.057	15c
" "	Sept. 17	18	68	56	22.9	41	10.02	1.72	14.33	14.2	1.060	62c
Early Orange	Aug. 6	9	32	24	11.75	49	11.99	1.66	15.97	.....	1.064	58
" "	Aug. 11	10	29	21	10	48	9.73	1.34	12.55	.....	1.054	99
" "	Aug. 23	12	30	22	9.5	43	9.64	.....	13.74	.....	1.057	77a
" "	Sept. 5	16	64	52	27.1	52	13.20	.....	.....	17.4	1.069	53b
" "	Sept. 11	17	104	75	39.4	52	14.43	1.45	19.77	19.4	1.078	20c
" "	Sept. 28	18	54	42	15	35	15.81	0.47	21.10	22.0	1.057	27d
Kansas Orange	Aug. 6	8	36	28	14.75	52	10.2	1.37	12.28	.....	1.055	59
" "	Aug. 11	10	40	31	14.4	46	11.46	1.75	14.57	.....	1.061	100
" "	Aug. 23	12	43	29	15	51	8.55	0.95	11.44	.....	1.048	78a
" "	Sept. 5	16	85	58	31.6	54	9.49	.....	.....	13.8	1.054	54b
" "	Sept. 11	17	80	60	29.6	49	13.39	1.13	17.34	18.5	1.074	19c
" "	Sept. 21	16	73	54	27.2	50	13.19	.....	18.86	19.2	1.078	85c
" "	Oct. 18	18	59	40	21.9	55	13.48	1.06	.....	18.4	1.074	21e
Medium Orange, Ill	July 31	10	20	15	12.1	.....	.....	1.20	12.60	.....	1.050	31
" " "	Aug. 4	11	54	40	.....	.....	.....	.....	.....	.....	.....	56
" " "	Aug. 7	12	49	36	20.1	55.9	11.54	0.96	12.23	.....	1.052	67
" " "	Aug. 10	12	52	38	21	55.2	9.18	0.80	13.19	.....	1.052	95
" " "	Aug. 14	13	32	26	12	46.1	13.54	1.76	17.42	.....	1.052	35a
" " "	Aug. 21	16	49	32	18.1	56.5	9.75	.....	13.73	.....	1.058	75a
" " "	Sept. 6	17	65	49	23.4	47.7	13.14	.....	.....	18.0	1.074	70b
" " "	Oct. 4	18	53	41	15.75	38.4	13.54	0.66	18.17	18.9	1.076	62d
Pierce's Cross	Aug. 1	11	55	41	22	53.7	9.43	1.45	12.60	.....	1.053	37
" "	Aug. 10	11	44	34	19.6	57.6	4.40	2.24	13.25	.....	1.030	97
" "	Aug. 13	12	58	47	25.75	54.8	8.77	2.25	13.58	.....	1.055	25a
" "	Aug. 20	13	35	28	16	57.1	7.46	.....	11.41	.....	1.047	66a
" "	Oct. 1	15	103	86	41	47.6	10.28	1.37	14.69	14.9	1.058	42d
" "	Oct. 18	18	46	36	39.5	.....	13.80	1.77	.....	18.5	1.072	17e
Golden Rod, Ga	Aug. 1	11	49	33	12.75	38.6	6.55	2.67	10.54	.....	1.041	38
" " "	Aug. 11	12	48	28	11.6	41.4	10.60	2.02	13.32	.....	1.056	6a

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Golden Rod, Ga	Aug. 13	12	30	20	6.9	34.5	6.26	3.62	11.15	.....	1.049	26 a
" " "	Aug. 21	14	34	22	6.4	29.1	7.64	.....	12.75	.....	1.052	68 a
" " "	Sept. 1	16	74	52	25.6	49.2	6.09	.....	.....	10.4	1.042	28 b
" " "	Sept. 20	18	61	42	19.2	45.9	9.80	2.91	15.24	15.6	1.063	78 c
Early Golden, Me	Aug. 2	11	47	38	18.75	49.3	9.98	.....	13.38	.....	1.054	43
" " "	Aug. 21	15	44	34	18.75	55.1	12.06	.....	15.77	.....	1.055	76 a
" " "	Sept. 8	15	63	43	23	53.5	9.75	.....	.....	14.8	1.058	1 c
" " "	Oct. 4	18	46	36	15.9	44.1	14.14	1.37	19.16	19.4	1.076	66 d
Sorghum from Tex	Aug. 2	11	38	29	14.7	50.6	9.07	.....	12.80	.....	1.051	44
" "	Aug. 10	12	40	32	19.1	59.7	9.73	1.43	12.35	.....	1.052	94
" "	Sept. 8	18	46	36	22.9	63.6	12.21	.....	.....	16.4	1.065	99 b
White Amber, Neb	Aug. 4	11	40	33	.....	.....	.....	.....	.....	.....	.....	55
" " "	Aug. 7	12	51	40	15	37.5	9.44	1.76	13.38	.....	1.055	68
" " "	Aug. 14	13	25	17	8.7	51.2	6.14	2.38	10.76	.....	1.044	34 a
" " "	Aug. 21	14	56	43	22.2	51.6	10.81	.....	14.70	.....	1.061	74 a
" " "	Sept. 21	16	72	58	33.9	58.4	10.34	.....	17.91	17.9	1.073	87 c
" " "	Oct. 3	17	74	63	23	36.5	12.94	1.47	.....	17.8	1.070	59 d
" " "	Oct. 16	18	60	51	26.1	51.1	11.68	.....	.....	16.6	1.065	1 e
W. from Kan	Aug. 7	10	52	43	22.75	52.9	7.14	1.31	15.28	.....	1.042	65
" "	Sept. 6	14	48	32	17	53.1	6.17	.....	.....	16.0	1.042	71 b
" "	Sept. 22	14	77	62	36.4	58.7	11.23	.....	.....	15.8	1.063	94 c
" "	Sept. 29	15	53	40	35.1	87.7(?)	13.71	.....	.....	18.2	1.074	41 d
" "	Oct. 4	16	56	46	21.4	46.5	13.12	1.98	17.76	18.2	1.073	67 d
" "	Oct. 16	17	68	50	24.1	48.2	14.03	.....	.....	19.2	1.076	5 e
Early Orange, S. C	Aug. 7	11	39	30	15.9	53.0	11.30	1.78	14.30	.....	1.057	66
" " "	Sept. 15	14	69	54	32.4	60.0	10.95	.....	.....	15.4	1.062	42 c
" " "	Sept. 22	15	78	59	32	54.2	13.67	.....	.....	18.0	1.071	93 c
" " "	Sept. 29	17	88	66	41	62.1	10.28	1.37	14.69	14.9	1.058	42 d
" " "	Oct. 4	17	54	44	21.5	48.8	15.47	1.34	15.56	19.8	1.076	65 d
" " "	Oct. 18	18	84	59	30.1	51.0	13.74	1.55	.....	18.4	1.074	26 e
Link's Hybrid	Aug. 13	9	42	30	15.6	55.3	8.30	.....	9.91	.....	1.040	7 a
" "	Aug. 23	11	51	35	20.1	57.4	9.32	1.50	13.20	.....	1.050	79 a

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr. ct. total Solids direct meth.	Pr. ct. total Solids by Brix.	Specific Gravity.	Analy's Number
White Idia	Sept. 10	17	100	76	45	59	6.90	3.19	10.71	11.4	1.046	4c
" "	Sept. 11	17	76	57	29.75	52	9.61	3.22	13.80	14.2	1.057	15c
" "	Sept. 17	18	68	56	22.9	41	10.02	1.72	14.33	14.2	1.060	62c
Early Orange	Aug. 6	9	32	24	11.75	49	11.99	1.66	15.97	.....	1.064	58
" "	Aug. 11	10	29	21	10	48	9.73	1.34	12.55	.....	1.054	99
" "	Aug. 23	12	30	22	9.5	43	9.64	.....	13.74	.....	1.057	77a
" "	Sept. 5	16	64	52	27.1	52	13.20	.....	.....	17.4	1.069	53b
" "	Sept. 11	17	104	75	39.4	52	14.43	1.45	19.77	19.4	1.078	20c
" "	Sept. 28	18	54	42	15	35	15.81	0.47	21.10	22.0	1.057	27d
Kansas Orange	Aug. 6	8	36	28	14.75	52	10.2	1.37	12.28	.....	1.055	59
" "	Aug. 11	10	40	31	14.4	46	11.46	1.75	14.57	.....	1.061	100
" "	Aug. 23	12	43	29	15	51	8.55	0.95	11.44	.....	1.048	78a
" "	Sept. 5	16	85	58	31.6	54	9.49	.....	.....	13.8	1.054	54b
" "	Sept. 11	17	80	60	29.6	49	13.39	1.13	17.34	18.5	1.074	19c
" "	Sept. 21	16	73	54	27.2	50	13.19	.....	18.86	19.2	1.078	85c
" "	Oct. 18	18	59	40	21.9	55	13.48	1.06	.....	18.4	1.074	21e
Medium Orange, Ill	July 31	10	20	15	12.1	.....	.....	1.20	12.60	.....	1.050	31
" " "	Aug. 4	11	54	40	.....	.....	.....	.....	.....	.....	.....	56
" " "	Aug. 7	12	49	36	20.1	55.9	11.54	0.96	12.23	.....	1.052	67
" " "	Aug. 10	12	52	38	21	55.2	9.18	0.80	13.19	.....	1.052	95
" " "	Aug. 14	13	32	26	12	46.1	13.54	1.76	17.42	.....	1.052	35a
" " "	Aug. 21	16	49	32	18.1	56.5	9.75	.....	13.73	.....	1.058	75a
" " "	Sept. 6	17	65	49	23.4	47.7	13.14	.....	.....	18.0	1.074	70b
" " "	Oct. 4	18	53	41	15.75	38.4	13.54	0.66	18.17	18.9	1.076	62d
Pierce's Cross	Aug. 1	11	55	41	22	53.7	9.43	1.45	12.60	.....	1.053	37
" "	Aug. 10	11	44	34	19.6	57.6	4.40	2.24	13.25	.....	1.030	97
" "	Aug. 13	12	58	47	25.75	54.8	8.77	2.25	13.58	.....	1.055	25a
" "	Aug. 20	13	35	28	16	57.1	7.46	.....	11.41	.....	1.047	66a
" "	Oct. 1	15	103	86	41	47.6	10.28	1.37	14.69	14.9	1.058	42d
" "	Oct. 18	18	46	36	39.5	.....	13.80	1.77	.....	18.5	1.072	17e
Golden Rod, Ga	Aug. 1	11	49	33	12.75	38.6	6.55	2.67	10.54	.....	1.041	38
" " "	Aug. 11	12	48	28	11.6	41.4	10.60	2.02	13.32	.....	1.056	6a

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Golden Rod, Ga	Aug. 13	12	30	20	6.9	34.5	6.26	3.62	11.15	.....	1.049	26 a
" " "	Aug. 21	14	34	22	6.4	29.1	7.64	.....	12.75	.....	1.052	68 a
" " "	Sept. 1	16	74	52	25.6	49.2	6.09	.....	.....	10.4	1.042	28 b
" " "	Sept. 20	18	61	42	19.2	45.9	9.80	2.91	15.24	15.6	1.063	78 c
Early Golden, Me	Aug. 2	11	47	38	18.75	49.3	9.98	.....	13.38	.....	1.054	43
" " "	Aug. 21	15	44	34	18.75	55.1	12.06	.....	15.77	.....	1.055	76 a
" " "	Sept. 8	15	63	43	23	53.5	9.75	.....	.....	14.8	1.058	1 c
" " "	Oct. 4	18	46	36	15.9	44.1	14.14	1.37	19.16	19.4	1.076	66 d
Sorghum from Tex	Aug. 2	11	38	29	14.7	50.6	9.07	.....	12.80	.....	1.051	44
" "	Aug. 10	12	40	32	19.1	59.7	9.73	1.43	12.35	.....	1.052	94
" "	Sept. 8	18	46	36	22.9	63.6	12.21	.....	.....	16.4	1.065	99 b
White Amber, Neb	Aug. 4	11	40	33	.....	.....	.....	.....	.....	.....	.....	55
" " "	Aug. 7	12	51	40	15	37.5	9.44	1.76	13.38	.....	1.055	68
" " "	Aug. 14	13	25	17	8.7	51.2	6.14	2.38	10.76	.....	1.044	34 a
" " "	Aug. 21	14	56	43	22.2	51.6	10.81	.....	14.70	.....	1.061	74 a
" " "	Sept. 21	16	72	58	33.9	58.4	10.34	.....	17.91	17.9	1.073	87 c
" " "	Oct. 3	17	74	63	23	36.5	12.94	1.47	.....	17.8	1.070	59 d
" " "	Oct. 16	18	60	51	26.1	51.1	11.68	.....	.....	16.6	1.065	1 e
W. from Kan	Aug. 7	10	52	43	22.75	52.9	7.14	1.31	15.28	.....	1.042	65
" "	Sept. 6	14	48	32	17	53.1	6.17	.....	.....	16.0	1.042	71 b
" "	Sept. 22	14	77	62	36.4	58.7	11.23	.....	.....	15.8	1.063	94 c
" "	Sept. 29	15	53	40	35.1	87.7(?)	13.71	.....	.....	18.2	1.074	41 d
" "	Oct. 4	16	56	46	21.4	46.5	13.12	1.98	17.76	18.2	1.073	67 d
" "	Oct. 16	17	68	50	24.1	48.2	14.03	.....	.....	19.2	1.076	5 e
Early Orange, S. C	Aug. 7	11	39	30	15.9	53.0	11.30	1.78	14.30	.....	1.057	66
" " "	Sept. 15	14	69	54	32.4	60.0	10.95	.....	.....	15.4	1.062	42 c
" " "	Sept. 22	15	78	59	32	54.2	13.67	.....	.....	18.0	1.071	93 c
" " "	Sept. 29	17	88	66	41	62.1	10.28	1.37	14.69	14.9	1.058	42 d
" " "	Oct. 4	17	54	44	21.5	48.8	15.47	1.34	15.56	19.8	1.076	65 d
" " "	Oct. 18	18	84	59	30.1	51.0	13.74	1.55	.....	18.4	1.074	26 e
Link's Hybrid	Aug. 13	9	42	30	15.6	55.3	8.30	.....	9.91	.....	1.040	7 a
" "	Aug. 23	11	51	35	20.1	57.4	9.32	1.50	13.20	.....	1.050	79 a

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per Cent. of Juice.	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Link's Hybrid	Sept. 5	15	78	52	27.6	53.0	9.82	.....	.....	14.4	1.057	55 b
" "	Sept. 11	16	82	58	33.1	57.1	11.13	3.04	16.66	16.8	1.068	18 c
" "	Sept. 17	17	83	59	33.1	56.1	11.74	0.86	14.88	16.2	1.068	49 c
" "	Sept. 28	18	53	43	21.2	49.3	13.35	2.26	17.45	19.1	1.077	28 d
Red Liberian	Aug. 13	8	44	33	11.4	34.5	5.63	5.89	12.02	.....	1.052	10 a
" "	Aug. 24	10	54	41	22	53.6	6.44	3.42	11.65	.....	1.048	84 a
" "	Sept. 5	16	78	58	32	55.1	10.39	.....	.....	15.6	1.061	60 b
" "	Sept. 17	17	66	48	24.9	51.8	11.26	3.03	15.78	16.0	1.069	53 c
" "	Sept. 28	18	72	53	23.4	44.1	14.36	2.42	18.74	19.6	1.079	30 d
Later Orange, N. J.	Aug. 8	10	60	46	23.1	50.2	9.30	2.31	12.84	.....	1.053	76
" " "	Aug. 14	11	35	29	14.6	50.3	9.53	4.38	15.12	.....	1.060	31 a
" " "	Sept. 1	12	60	41	25.1	61.2	6.66	.....	.....	10.7	1.043	29 b
" " "	Sept. 14	14	123	89	53.2	59.7	9.73	4.15	13.73	13.7	1,056	37 c
" " "	Sept. 21	15	86	64	32.2	50.3	11.54	.....	16.18	17.0	1.069	81 c
" " "	Oct. 1	16	91	64	32.9	51.4	12.81	1.43	16.56	17.4	1.069	45 d
" " "	Oct. 9	17	68	49	22.4	45.7	11.85	1.27	.....	19.1	1.075	92 d
" " "	Oct. 17	18	49	39	37.6	96.5(?)	11.53	3.31	.....	16.5	1.063	12 e
" " "	Oct. 18	18	78	59	27.5	45.6	13.81	1.68	.....	18.7	1.075	20 e
Honey Dew, Ind	Aug. 8	8	63	42	21.2	50.5	7.68	1.65	11.04	.....	1.049	77
" " "	Sept. 15	13	61	39	18.9	48.4	9.72	.....	.....	15.6	1.061	41 c
" " "	Sept. 22	15	50	38	20.9	55.0	11.76	.....	.....	17.4	1.074	92 c
" " "	Oct. 4	16	56	47	20.9	44.4	13.59	0.92	18.72	19.7	1.078	64 d
" " "	Oct. 9	17	66	44	22.5	51.1	14.52	1.41	.....	19.5	1.077	97 d
" " "	Oct. 19	18	103	80	.....	.....	.....	.....	.....	.....	.....	52 e
Chinese Sug'r Cane, France	Aug. 8	10	36	29	17.6	60.7	10.13	2.83	14.33	.....	1.058	78
" " " "	Sept. 8	14	89	71	42.6	60.0	10.31	.....	.....	14.5	1.058	100 b
" " " "	Sept. 15	11	80	63	26.6	42.2	10.48	.....	.....	15.4	1.060	44 c
" " " "	Sept. 29	13	86	72	20.9	27.6	11.42	.....	.....	16.8	1.068	40 d
" " " "	Oct. 4	17	62	46	15.4	35.7	16.37	0.64	21.28	21.5	1.085	69 d
Link's Hybrid, Ft. Scott	Aug. 10	10	35	28	16.75	59.7	10.24	1.32	13.08	.....	1.053	96
" " "	Aug. 27	12	48	32	18.1	.....	8.63	0.99	13.87	.....	1.051	94 a
" " "	Sept. 6	14	68	47	22.2	47.2	10.16	.....	.....	15.6	1.061	63 b

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr. ct. total Solids direct meth.	Pr. ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Link's Hybrid, Ft. Scott	Oct. 3	16	60	44	20.75	47.1	13.76	1.37	.....	18.6	1.054	58 d
" " "	Oct. 9	17	39	35	15	42.8	10.01	0.74	.....	15.7	1.062	93 d
" " "	Oct. 16	18	62	47	18.75	40.0	13.76	.....	.....	19.2	1.076	98 d
Honey Cane, Texas	Aug. 14	10	44	32	17.75	55.4	8.77	2.50	12.82	.....	1.052	32 a
" " "	Oct. 3	16	69	54	31.6	58.5	9.49	.....	.....	13.8	1.054	54 b
" " "	Oct. 9	17	72	50	21.5	43.0	14.51	2.07	.....	19.6	1.079	90 d
" " "	Oct. 18	18	53	42	17.1	40.7	9.34	4.19	.....	14.4	1.057	18 e
Honduras, from La.	Aug. 21	11	48	38	17	44.7	6.99	.....	11.76	.....	1.047	67 a
" "	Sept. 1	13	62	50	29.6	59.2	8.96	.....	.....	12.8	1.054	27 b
" "	Sept. 14	14	112	80	28.9	36.1	7.52	2.91	11.90	12.4	1.052	34 c
" "	Sept. 20	15	88	71	37.6	53.5	11.02	4.43	16.00	15.8	1.064	78 c
" "	Oct. 19	18	88	64	29.4	45.9	11.99	2.28	.....	17.0	1.072	27 e
Red Top, Texas	Aug. 21	9	39	30	15.9	53.0	11.64	.....	16.34	.....	1.066	70 a
" "	Sept. 1	11	83	61	35.5	58.3	12.22	.....	.....	16.0	1.064	31 b
" "	Oct. 17	17	100	78	23.2	29.7	8.52	1.97	.....	13.4	1.052	15 e
New Variety, Cent. Amer.	Aug. 21	12	49	39	20.7	53.1	9.87	.....	13.67	.....	1.055	73 a
" "	Sept. 6	14	45	36	18.5	57.4	11.73	.....	.....	11.4	1.066	67 b
White Mammoth, Ga.	Aug. 27	11	53	42	22.5	53.5	7.78	3.25	12.09	.....	1.049	92 a
" " "	Oct. 3	16	69	49	23	46.9	13.50	1.01	.....	19.2	1.075	55 d
" " "	Oct. 9	17	38	33	14.2	43.0	13.92	1.84	.....	19.0	1.075	91 d
" " "	Oct. 19	18	103	72	33.6	46.6	13.72	2.70	.....	18.4	1.077	29 e
" " Kansas	Aug. 27	11	56	40	22	55.0	6.16	2.27	10.31	.....	1.004	96 a
" " "	Sept. 6	14	85	61	33.1	54.2	7.53	.....	.....	12.4	1.050	66 b
" " "	Oct. 16	18	57	51	24.9	48.8	12.51	.....	.....	17.4	1.069	100 d
Dutch Amber, Iowa	Aug. 27	13	64	45	23.2	51.5	9.91	1.68	13.40	.....	1.054	97 a
" " "	Sept. 6	15	59	44	24.6	55.9	11.73	.....	.....	16.0	1.064	68 b
" " "	Sept. 22	16	75	55	26.2	47.6	12.54	.....	.....	16.6	1.067	89 c
" " "	Oct. 3	17	63	53	27	49.0	13.56	1.08	.....	18.4	1.073	60 d
" " "	Oct. 16	17	70	59	27.5	46.6	12.58	.....	.....	17.3	1.069	7 e
" " "	Oct. 18	18	68	44	23.2	52.7	12.31	1.31	.....	17.0	1.066	24 e
Goose Neck, Texas	Aug. 27	10	43	30	16.5	55.0	8.51	2.96	13.15	.....	1.053	98 a
" " "	Oct. 9	17	69	54	23.75	53.2	13.23	0.99	.....	19.2	1.077	95 d

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per Cent. of Juice	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Goose Neck, Tex.	Oct. 16	18	88	63	27.6	43.8	13.10	.....	.....	19.0	1.075	2 e
Enyama	Aug. 27	11	60	43	22.2	51.6	8.74	1.69	13.09	.....	1.052	99 a
"	Sept. 6	14	54	40	22.9	57.2	8.13	.....	.....	12.6	1.052	69 b
"	Sept. 22	16	87	72	38.4	53.3	12.27	.....	.....	17.0	1.068	90 c
"	Oct. 16	17	90	80	37.6	47.0	13.81	.....	.....	19.3	1.076	3 e
Honey Drip, Ind	Aug. 27	11	70	46	24.1	52.4	6.87	1.25	10.81	.....	1.046	100 a
" "	Oct. 18	18	78	55	24.9	45.2	13.54	1.17	.....	18.6	1.074	25 e
Russell's New Variety	Aug. 27	11	44	32	16.9	52.8	7.06	2.36	11.66	.....	1.050	1 b
" "	Sept. 15	14	79	55	29.5	54	11.50	.....	.....	16.4	1.065	40 c
" "	Sept. 22	15	84	56	31.4	56	12.13	.....	.....	17.4	1.069	91 c
" "	Oct. 4	16	66	49	22.75	46	14.04	0.82	18.85	19.4	1.076	63 d
" "	Oct. 9	17	66	44	22.5	51	14.52	1.41	.....	19.5	1.077	97 d
" "	Oct. 16	18	65	47	21.4	45	13.76	.....	.....	19.4	1.076	4 e
Club Head, A. T.	Sept. 1	11	53	38	20.75	54	9.68	.....	.....	14.5	1.059	26 b
Little Shanch	Sept. 14	14	80	51	45.9	90(?)	9.38	3.03	12.44	13.4	1.053	35 c
" "	Oct. 1	15	73	53	26.5	50	12.07	3.37	19.06	17.0	1.071	43 d
" "	Oct. 17	17	57	44	28	63	14.50	1.19	.....	19.8	1.080	10 e
" "	Oct. 19	18	67	51	22.75	44	13.61	2.96	.....	19.0	1.076	28 o
Silver Top, Tex	Sept. 14	12	125	95	52	54	10.59	3.80	14.71	14.2	1.058	36 c
" " "	Oct. 1	14	70	58	28.75	49	10.57	3.63	14.91	15.0	1.059	44 d
" " "	Oct. 9	17	51	40	17.1	43	13.55	2.08	.....	18.1	1.073	88 d
" " "	Oct. 17	16	84	71	21.75	30	14.01	3.38	.....	19.4	1.075	11 e
Yellow Douro	Oct. 3	15	60	39	34.75	89(?)	10.88	.....	.....	13.0	1.051	61 b
" "	Oct. 9	17	70	48	33.1	69	13.50	0.69	.....	19.2	1.076	94 d
Hybrid No. 1	Aug. 13	9	38	23	15	65	8.28	2.13	12.83	.....	1.051	11 a
" "	Aug. 15	10	48	37	21.9	59	8.08	.....	12.96	.....	1.052	44 a
" "	Aug. 24	11	38	29	16.9	58	6.84	2.45	11.26	.....	1.046	86 a
" "	Sept. 5	15	82	61	34.75	57	10.88	.....	.....	13.0	1.051	61 b
" "	Sept. 10	16	88	66	35.4	53	11.22	0.76	14.62	14.8	1.060	2 c
" "	Sept. 17	16	76	58	30.6	54	11.71	0.97	15.57	16.1	1.066	54 c
" "	Sept. 28	17	67	53	27.4	51	13.40	1.32	17.15	18.4	1.074	31 d
" "	Oct. 6	18	62	47	22.1	47	13.35	.....	.....	18.3	1.073	82 d

VARIETY.	Date.	Stage.	Weight Unstrip'd Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent. of Juice.	Per cent. of Sucrose.	Per cent. of Glucose.	Pr. ct. total Solids, direct meth.	Pr. ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 2	Aug. 13	9	65	48	19.9	41	6.24	1.46	12.20	.....	1.042	12 a
" "	Aug. 24	10	62	43	22.1	51	6.79	1.93	11.27	.....	1.049	86 a
" "	Sept. 3	13	60	36	13.2	36	5.56	.....	.....	11.0	1.040	41 b
" "	Sept. 13	15	92	65	26.9	41	10.55	.....	16.11	17.0	1.069	22 c
" "	Sept. 18	16	51	37	20	54	9.83	.....	.....	14.6	1.059	93 b
" "	Sept. 28	17	110	76	22.75	30	.....	.....	.....	.....	.....	32 d
" "	Oct. 6	18	47	29	11.6	40	12.52	.....	.....	18.4	1.071	83 d
Hybrid No. 3	Aug. 6	9	36	26	8	30	7.88	1.29	12.31	.....	1.047	60
" "	Aug. 15	10	39	25	22	88	8.74	.....	13.39	.....	1.057	43 a
" "	Aug. 24	11	31	20	6	30	8.23	1.34	12.87	.....	1.053	87 a
" "	Sept. 3	14	53	32	16.6	52	8.88	.....	.....	8.8	1.035	40 b
" "	Sept. 13	16	60	39	16.1	41	12.77	1.57	17.54	18.8	1.077	23 c
" "	Sept. 28	17	88	67	33.5	50	12.69	0.82	16.52	18.0	1.072	33 d
" "	Oct. 6	18	58	34	9.75	28	13.49	.....	.....	18.9	1.075	84 d
Hybrid No. 4	Aug. 13	9	38	29	12.5	43	5.29	2.51	9.40	.....	1.040	13 a
" "	Aug. 24	11	50	37	21.2	57	9.30	2.75	14.16	.....	1.060	88 a
" "	Sept. 3	15	77	56	34.5	61	8.11	.....	.....	7.8	1.032	39 b
" "	Sept. 13	16	86	66	37.6	57	10.94	0.72	14.11	15.4	1.063	24 c
" "	Sept. 18	16	65	51	28	49	8.66?	.....	.....	13.2	1.053	94 b
" "	Sept. 24	17	94	70	34.6	49	10.65	0.54	13.85	15.2	1.059	3 d
" "	Sept. 28	18	81	54	46.1	85	11.02	0.89	14.87	16.4	1.067	34 d
Hybrid No. 5	Aug. 2	10	85	69	22	32	6.15	.....	11.50	.....	1.044	40
" "	Aug. 16	13	37	28	14.4	51	8.44	.....	11.91	.....	1.048	42 a
" "	Sept. 3	15	78	57	27.5	48	13.39?	.....	.....	19.4	1.076	38 d
" "	Sept. 13	16	73	54	29	53	10.75	1.44	15.32	15.8	1.064	25 c
" "	Sept. 24	17	108	77	44.6	58	10.47	1.38	14.94	15.4	1.060	2 d
" "	Oct. 6	18	69	44	21.1	48	9.58	.....	.....	15.4	1.060	85 d
Hybrid No. 6	Aug. 6	9	39	31	17.6	57	6.03?	1.40	14.37	.....	1.044	62
" "	Sept. 3	14	58	47	26.6	56	10.13	.....	.....	10.6	1.058	37 b
" "	Sept. 13	16	85	65	33.5	51	12.87	0.54	18.69	19.4	1.081	26 c
" "	Oct. 6	18	60	45	22.9	51	12.87	.....	.....	18.2	1.072	87 d
Hybrid No. 7	Aug. 2	10	84	69	22.6	34	9.37	.....	12.73	.....	1.032	42

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped Ounces.	Weight of Juice.	Per Cent of Juice.	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids. direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 7	Aug. 6	12	38	29	12.05	43	10.59?	0.88	14.26	.....	1.060	61
" " "	Aug. 13	12	48	37	19	51	8.88	1.25	12.67	.....	1.046	14 a
" " "	Aug. 16	13	35	25	14.9	59	10.72	.....	15.04	.....	1.062	40 a
" " "	Aug. 24	15	44	34	19	56	10.37	0.71	14.18	.....	1.061	91 a
" " "	Sept. 13	17	73	58	32.1	57	10.18	1.23	14.16	15.0	1.059	27 c
" " "	Sept. 24	18	76	58	33.7	58	10.84	0.91	14.31	15.7	1.069	100 c
Hybrid No. 8	Aug. 13	10	47	37	16.5	44	8.30	2.50	13.09	.....	1.052	15 a
" " "	Sept. 3	14	57	44	25.2	57	10.21	.....	.....	13.8	1.055	35 b
" " "	Sept. 13	16	85	64	34.6	54	11.51	1.47	15.55	16.0	1.065	28 c
" " "	Sept. 24	17	87	63	37.5	59	11.57	1.52	13.94	14.6	1.068	99 c
" " "	Oct. 6	18	52	39	17.4	44	12.34	.....	.....	17.2	1.067	86 d
Hybrid No. 9	Aug. 7	9	48	38	21.4	56	8.99	0.90	12.19	.....	1.054	64
" " "	Aug. 8	10	58	47	24.75	52	9.74	1.70	13.00	.....	1.053	79
" " "	Aug. 15	11	47	34	17.4	51	8.90	.....	12.87	.....	1.054	39 a
" " "	Sept. 3	14	61	46	25.6	55	12.47	.....	.....	15.8	1.068	34 b
" " "	Sept. 13	16	79	59	32.6	55	14.32	1.14	18.24	19.0	1.074	29 c
" " "	Sept. 15	17	94	69	26.4	44	14.70	.....	.....	18.2	1.075	45 c
" " "	Sept. 24	17	83	61	31.2	51	14.51	0.65	.....	17.4	1.079	98 c
" " "	Sept. 28	18	70	48	10	20	14.21	.....	.....	18.2	1.070	37 d
Hybrid No. 10	July 31	11	29	22	20	....	.....	0.33	10.61	.....	1.042	30
" " "	Aug. 7	12	58	43	19.5	46	6.56	0.94	10.03	.....	1.034	63
" " "	Aug. 8	12	42	28	11.5	44	5.72	1.75	12.20	.....	1.042	80
" " "	Aug. 15	13	27	20	6.1	30	7.22	.....	15.14	.....	1.060	38 a
" " "	Sept. 3	15	54	40	22.1	55	7.31	.....	.....	12.2	1.050	33 b
" " "	Sept. 8	16	49	25	11.4	45	6.27	.....	.....	11.8	1.047	97 b
" " 10A	Sept. 15	17	52	33	10.75	32	11.67	.....	.....	18.0	1.073	46 c
" " "	Sept. 24	17	72	46	20	43	11.14	0.80	15.47	16.6	1.070	97 c
" " "	Sept. 29	18	50	32	27.5	86	13.39	.....	.....	19.4	1.076	38 d
Hybrid No. 11	July 31	11	21	16	18	....	.....	1.18	10.75	.....	1.042	32
" " "	Aug. 13	12	49	36	11	30	.....	.....	12.08	.....	1.045	16
" " "	Aug. 15	13	41	31	15.4	49	7.29	2.98	12.55	.....	1.052	37 a

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per Cent. of Juice.	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 11	Sept. 3	15	87	63.	36	57	9.80	.....	.....	13.6	1.054	32b
" " "	" 15	16	71	51	36.4	71	13.20	.....	.....	18.4	1.073	47c
" " "	" 29	17	83	62	33.1	53	12.99	.....	.....	18.0	1.071	39d
" " 12	Aug. 14	9	40	32	17	53	7.50	3.63	13.90	.....	1.040	18a
" " "	Aug. 20	11	40	28	12.6	44	7.82	.....	11.45	.....	1.047	57a
" " "	Aug. 29	13	61	43	21.2	49	8.86	1.78	11.66	.....	1.048	12b
" " "	Sept. 7	15	44	33	13.4	40	11.09	.....	.....	15.4	1.062	72b
" " "	Sept. 18	16	77	57	25.1	44	13.88	1.04	18.39	18.5	1.079	56c
" " "	" 26	17	54	39	10.6	27	13.71	.....	.....	17.8	1.073	12d
" " "	Oct. 5	18	67	44	39.9	90	13.80	67	.....	18.9	1.076	70d
" " 13	Aug. 14	9	53	37	20	54	5.09	4.38	10.24	.....	1.043	17a
" " "	Aug. 20	11	54	38	21.5	56	7.03	.....	11.41	.....	1.045	58a
" " "	Aug. 29	13	57	42	24.6	58	.....	3.75	9.16	.....	.....	13b
" " "	Sept. 9	15	61	44	24.1	54	6.74	.....	11.4	.....	1.043	73b
" " "	" 18	16	86	61	36.7	60	7.51	2.74	11.72	12.0	1.049	57c
" " "	" 26	17	105	80	37.8	47	11.69	.....	.....	17.0	1.070	13d
" " "	Oct. 5	18	79	64	24.5	38	11.82	2.06	.....	17.0	1.069	71d
" " 15	Aug. 14	11	33	24	13	54	11.31	2.88	15.22	.....	1.064	19a
" " "	" 29	12	53	40	23.4	58	10.54	2.58	14.05	.....	1.059	14b
" " "	Sept. 9	14	48	37	20.6	57	10.77	.....	.....	14.6	1.060	74b
" " "	" 18	15	92	68	35	51	11.78	1.52	18.93	18.2	1.075	58c
" " "	" 26	16	76	59	31.5	53	14.17	.....	.....	19.3	1.076	15d
" " "	Oct. 5	17	86	66	29.4	44	15.36	0.98	.....	19.6	1.079	72d
" " "	" 17	18	83	71	22.5	31	15.92	0.76	.....	20.7	1.083	8c
" " 16	Aug. 1	10	59	44	21	47	8.18	0.91	11.35	.....	1.047	33
" " "	" 8	11	40	32	17.1	53	9.72	2.42	12.99	.....	1.055	71
" " "	" 14	12	32	21	9.9	47	9.27	1.82	12.17	.....	1.054	20a
" " "	" 20	13	43	32	16.6	55	9.05	.....	11.20	.....	1.055	59a
" " "	" 29	15	48	37	18.5	50	9.60	0.86	12.84	....	1.054	15b
" " "	Sept. 9	16	52	39	20.6	53	9.61	.....	.....	12.8	1.052	75b
" " "	Sept. 18	17	90	66	38.9	59	11.01	0.71	16.08	15.7	1.065	59c

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per Cent. of Juice	Per Cent. of Sucrose.	Per Cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 16	Sept. 26	17	81	63	25.1	39	14.34	.....	.....	19.8	1.077	16 d
" " "	Oct. 5	18	72	57	30	52	15.32	0.38	.....	2.04	1.081	73 d
" " 17	Aug. 11	10	35	28	16.75	60	8.13	2.18	12.73	.....	1.053	1 a
" " "	" 14	11	42	32	16.75	52	8.74	3.79	15.09	.....	1.057	28 a
" " "	Sept. 9	12	54	41	23	56	9.04	.....	.....	13.8	1.054	76 b
" " "	" 18	13	64	46	27.1	59	11.29	1.86	16.04	16.3	1.066	60 c
" " "	" 26	15	102	82	34.4	42	13.89	.....	.....	19.2	1.078	17 d
" " "	Oct. 5	18	104	79	16.6	21	14.32	0.82	.....	19.7	1.078	74 d
" " 18	Aug. 8	9	48	35	16.5	47	7.78	3.59	12.39	.....	1.052	72
" " "	" 20	11	59	43	23.2	54	9.08	.....	12.76	.....	1.053	60 a
" " "	" 29	13	52	37	20.2	54	9.09	3.84	12.57	.....	1.053	17 b
" " "	Sept. 9	15	48	36	17.9	50	11.10	.....	.....	16.0	1.064	77 b
" " "	" 18	16	93	75	42.6	56	11.69	3.06	15.84	16.0	1.067	61 c
" " "	" 26	17	76	60	26.4	44	13.39	.....	.....	18.8	1.074	18 d
" " "	Oct. 5	18	57	45	21.2	47	14.87	1.45	.....	19.2	1.074	75 d
" " 19	Aug. 1	9	50	39	20	51	8.20	.....	10.90	.....	1.049	34
" " "	" 11	10	48	36	21	58	8.87	3.21	11.68	.....	1.046	2 a
" " "	" 14	12	48	37	21	57	9.94	1.78	13.36	.....	1.057	21 a
" " "	" 20	13	57	42	22.4	53	9.19	.....	11.91	.....	1.050	61 a
" " "	" 29	14	62	47	26.7	51	.....	3.69	10.59	.....	1.044	18 b
" " "	Sept. 9	16	43	32	19.1	59	9.80	.....	.....	14.6	1.059	78 b
" " "	" 18	17	83	61	42.1	69	10.86	2.92	15.97	15.6	1.064	62 c
" " "	" 26	18	80	60	36	60	12.39	.....	.....	18.0	1.073	19 d
" " 20	Aug. 1	11	46	33	16	48	6.12	0.80	9.03	.....	1.035	35
" " "	" 14	13	39	29	14.4	49	.....	1.52	13.42	.....	.....	22 a
" " "	" 20	14	41	30	17.6	58	7.45	.....	10.81	.....	1.045	62 a
" " "	" 29	15	71	48	27.1	56	9.98	0.74	13.40	.....	1.055	19 b
" " "	Sept. 9	16	78	49	25	51	9.72	.....	.....	14.2	1.058	79 b
" " "	" 18	17	79	59	31.9	54	12.12	0.71	.....	17.2	1.071	63 c
" " "	" 26	17	92	70	29.1	41	12.96	.....	.....	18.2	1.073	20 d
" " "	Oct. 5	18	....	....	15.5	....	13.08	0.76	.....	17.6	1.069	77 d
" " 21	Aug. 7	10	43	30	16.2	54	5.28	1.67	8.80	.....	1.038	69

VARIETY.	Date.	Stage.	Weight Unstrip'd. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 21	Aug. 14	10	38	28	13.4	48	8.10	2.28	12.04	.....	1.053	33a
" " "	" 20	12	42	31	16.6	50	9.08	.....	11.68	.....	1.050	63a
" " "	" 29	15	48	35	19.2	54	9.05	1.60	10.77	12.00	1.048	20b
" " "	Sept. 9	16	74	56	29.75	53	9.87	.....	.....	13.4	1.052	80b
" " "	" 20	16	73	55	23.1	41	.....	0.66	18.59	18.6	1.077	72c
" " "	" 27	17	55	39	11.75	30	10.73	.....	14.96	16.0	1.064	21d
" " 22	Aug. 8	10	40	32	18.1	56	5.41	2.70	12.37	.....	1.053	73
" " "	" 14	11	42	31	15.6	50	5.69	3.56	10.77	.....	1.044	29a
" " "	" 29	13	69	53	27.6	52	8.60	3.42	13.42	13.60	1.054	21b
" " "	Sept. 9	15	79	57	34.2	60	8.61	.....	.....	12.6	1.052	81b
" " "	" 20	16	110	83	47.2	56	12.18	2.94	17.03	17.6	1.073	73c
" " "	" 27	17	71	52	23.2	44	12.12	0.61	15.83	17.0	1.069	22d
" " "	Oct. 6	18	65	50	20.1	40	12.61	.....	.....	17.6	1.071	78d
" " 23	Aug. 4	10	35	24	.....	....	.....	.....	.....	.....	.....	52
" " "	" 11	11	24	16	9.75	61	5.81	1.13	11.24	.....	1.044	3a
" " "	" 14	12	46	34	16.2	47	6.52	1.89	10.22	.....	1.045	24a
" " "	" 20	13	34	23	11.5	50	6.01	.....	9.57	.....	1.040	64a
" " "	Sept. 1	16	46	28	9.2	35	6.08	.....	.....	.....	1.038	22b
" " "	" 14	17	55	37	16.6	44	8.87	1.25	12.94	14.2	1.057	30c
" " "	" 20	17	75	61	24.6	40	8.33	2.24	16.63	16.6	1.058	74c
" " "	" 27	18	68	53	24.5	46	11.93	3.26	13.14	14.5	1.074	23o
" " 24	Aug. 11	10	41	29	14.75	50	11.25	2.18	10.23	.....	1.040	4a
" " "	" 14	9	38	28	14.9	53	11.01	3.24	12.22	.....	1.050	30a
" " "	Sept. 1	11	55	41	21.4	52	11.11	.....	.....	15.0	1.061	23b
" " "	" 14	14	73	47	24.75	52	11.12	2.70	15.57	15.4	1.064	31c
" " "	" 20	15	85	64	32.4	50	11.02	2.71	12.88	18.0	1.064	75c
" " "	" 27	16	70	55	16.1	29	12.80	0.81	14.23	15.7	1.074	24d
" " "	Oct. 6	17	58	44	17.4	39	14.10	.....	.....	19.0	1.075	79d
" " "	" 17	18	65	54	23.4	43	14.94	1.64	.....	20.3	1.081	9e
" " 25	Aug. 1	9	38	27	11.9	44	6.01	2.26	9.10	.....	1.036	36
" " "	" 20	11	44	30	17.9	59	5.89	.....	8.17	.....	1.035	65a
" " "	Sept. 1	12	63	47	24.1	51	10.48	.....	.....	14.5	1.059	25b

VARIETIES.	Date.	Stage.	Weight Unstrip'd Ounces.	Weight Stripped Ounces.	Weight of Juice.	Per cent. of Juice.	Per cent. of Sucrose.	Per cent. of Glucose.	Pr.ct. total Solids, direct meth.	Pr.ct. total Solids by Brix.	Specific Gravity.	Analy's Number
Hybrid No. 25	Sept. 14	15	54	38	17	44	10.17	1.06	13.80	14.8	1.060	32c
" " "	" 20	16	67	49	24	49	11.66	2.15	17.26	17.2	1.069	76c
" " "	" 27	17	78	62	29.1	47	11.85	0.93	15.79	16.9	1.069	25d
" " "	Oct. 6	18	68	56	21.5	38	12.76	.....	.....	18.4	1.073	80d
" " 26	Aug. 8	9	47	36	19.6	54	7.65	3.83	12.57	.....	1.051	74
" " "	" 11	10	44	32	19.2	60	10.87	3.28	11.11	.....	1.047	5a
" " "	Sept. 1	12	63	47	24.1	51	10.48	.....	.....	14.5	1.059	25b
" " "	" 14	14	85	58	36.9	63	10.01	2.00	12.39	13.8	1.055	33c
" " "	" 20	15	77	56	27.4	49	10.72	2.58	15.87	16.2	1.065	77c
" " "	" 27	16	80	60	25.1	42	12.04	1.03	15.81	17.3	1.069	26d
" " "	Oct. 6	17	52	39	14.2	36	12.49	.....	.....	19.4	1.074	81d

The following table is an extract from the results obtained on all our varieties. It shows all Sorghum that made over twelve per cent. of sucrose, and indicates the varieties that we shall select for future work:

VARIETY.	DATE.	STAGE.	PER CENT SUCROSE.	PER CENT GLUCOSE.	PER CENT JUICE.
Early Amber	Sept. 5	16	14.10	.....	47
" "	" 11	18	14.32	1.28	56
Texas Honey Drip	" 10	17	12.57	2.24	53
New Orange	" 17	16	12 77	1.88	43
" "	" 21	16	12.65	.....	58
" "	" 28	17	13.21	3.26	48
Early Orange	" 5	16	13.20	.....	52
" "	" 11	17	14.43	1.25	52
" "	" 28	18	15.81	0.47	35
Kansas Orange	" 11	16	13.19	1.13	49
" "	" 21	17	13.39	.....	50
" "	Oct. 18	18	13.48	1.06	55
Medium Orange, Ill	Aug. 14	13	12.54	1.76	46
" " "	Sept. 6	17	13.14	.....	47
" " "	Oct. 4	18	13.54	0.66	38
Pierce's Cross	" 18	18	13.80	1.77	...
Early Golden, Me	Aug. 21	15	12.06	.....	55
" "	Oct. 4	18	14.14	1.37	44
Sorghum from Texas	Sept. 8	18	12.21	.....	63
White Amber, Neb	Oct. 3	17	12.94	1.47	36
W. from Kansas	Sept. 29	15	13.71	.....	87 ?
" " "	Oct. 4	16	13.12	1.98	46
" " "	" 16	17	14.03	.....	48
Early Orange, S. C	Sept. 22	15	13.67	.....	54
" " "	Oct. 4	17	15.47	1.34	48
" " "	" 18	18	15.74	1.55	51
Link's Hybrid	Sept. 28	18	13.35	2.26	49
Red Liberian	" 28	18	14.36	2.42	44
Later Orange, N. J	Oct. 1	16	12.81	1.43	51
" " "	" 18	18	13.81	1.68	45
Honey Dew, Ind	" 4	16	13.59	0.92	44
" " "	" 9	17	14.52	1.41	51
Chinese Sugar Cane, France	" 4	17	16.37	0.64	35
Link's Hybrid, Ft. Scott	" 3	16	13.76	1.31	47

Object of Experiments.

The experiments we made to determine the effect of fertilizers on the percentage of sucrose are so far without showing any very material benefit to result from the mixtures, etc., that we tried. The land was new and evidently contained a sufficient quantity of the elements of plant food to render the application of artificial aids unnecessary. The variety of sorghum used in these experiments was the Early Amber. The average yield of sucrose per cent. on the unfertilized plots running from 14.10 to 14.92 in the sixteenth and seventeenth stages. Of course it will not do to lose sight of the fact that on plot two using one hundred and fifty pounds of sodic nitrate to the acre we ran up to 15.01 per cent. of sucrose nor that in plot three with one hundred and fifty pounds muriate of potash we obtained 15.85 per cent. of sucrose. The addition of these compounds has certainly made some difference, but we prefer to reserve our opinion as to their value until we can confirm them another year. The sugar beet has been improved by selection, etc., and we see no reason why we should not be able to accomplish the same for sorghum. There is another point in this industry that is of great importance, that is to have the crop of the farmers supplying the factory, ripening consecutively so that the works may run as long as possible. On examination of our tables the dates at which the various varieties ripened may be noticed. We intend working further along this line. We find a great difficulty in this work owing to the extreme rarity of pure seed and the continual trouble due the mixtures. We have culled very carefully and expect to have less annoyance in future.

Plot	Date.	Stage.	FERTILIZER, PER ACRE.	Weight Unstripped Ounces.	Weight Stripped Ounces.	Weight of Juice.	Per Cent of Juice.	Per Cent of Sucrose.	Per Cent of Glucose.	Per Cent of Total Solids.	Specific Gravity.	Analysis Number
1	Aug. 9	10	300 pounds Superphosphate	30	24	10.1	41	9.81	1.73	13.12	1.052	81
1	Sept. 4	14		65	50	22.9	46	12.73		17.4 B*	1.072	42 b
1	Sept. 19	16		70	57	28.7	50	13.54	1.23	18.18	1.072	64 c
1	Oct. 2	18		84	64	33.1	51	13.30	1.17	18.79	1.076	48 d
3	Aug. 9	10	150 pounds Sodic Nitrate	38	29	15.5	53	8.96	1.87	12.47	1.053	82
2	Sept. 4	15		64	53	28.2	53	12.64		17.8 B*	1.074	43 b
2	Sept. 19	17		45	36	16.7	46	15.01	0.99	19.43	1.078	65 c
2	Oct. 2	18		71	58	25.5	44	14.95	1.09	18.83	1.077	49 d
3	Aug. 9	9	150 pounds Muriate Potash	44	34	19.2	56	9.99	2.19	13.78	1.055	83
3	Sept. 4	14		87	72	39.5	54	13.24		17.6 B*	1.073	44 b
3	Sept. 19	16		64	51	26.9	52	14.37	1.21	18.74	1.076	66 c
3	Oct. 2	18		58	45	20.9	46	15.85	0.65	20.03	1.084	50 d
4	Aug. 9	10	150 pounds Kainit	38	31	16.7	54	10.14	2.09	14.07	1.057	84
4	Sept. 4	15		77	63	34	54	12.73		17.8 B*	1.072	45 b
4	Sept. 19	17		64	50	25.5	51	14.66	1.27	19.09	1.076	67 c
4	Oct. 2	18		68	59	29.5	50	14.52	1.19	18.87	1.076	51 d
5	July 30	9	300 pounds Superphosphate 150 pound Nitrate Soda	18?	14?	15.1			2.42	14.43	1.053	21
5	Aug. 3	10	300 pounds Superphosphate 150 pounds Nitrate Soda	41	33	15.5	47			14.54	1.058	45
5	Aug. 9	10		35	26	16.6	64	9.27	2.18	12.98	1.055	85
5	Aug. 16	12		45	35	19.6	56	9.31		13.73	1.058	56 a
5	Aug. 28	14		40	31	16.2	52	12.72	1.06	16.37	1.069	11 b

*Brix.

Plot	Date.	Stage.	FERTILIZER, PER ACRE.	Weight Unstripped. Ounces.	Weight Stripped Ounces.	Weight of Juice.	Per Cent of Juice.	Per Cent. of Sucrose.	Per Cent. of Glucose.	Per Cent. of Total Solids.	Specific Gravity.	Analysis Number.
5	Sept. 4	15	.....	60	49	35.1	71	13.31	.....	17.2 B*	1.069	40d
5	Sept. 19	17	.....	36	26	11.7	45	12.56	2.39	17.51	1.073	68c
5	Oct. 2	18	.....	64	48	17.6	36	14.51	0.75	19.20	1.081	52d
6	July 30	8	150 pounds Nitrate Soda ..... 150 pounds Kainit.....	16(?)	12(?)	13	.....	.....	2.49	13.41	1.051	22
6	Aug.	9	.....	46	35	21.5	61	11.13	1.98	14.61	1.062	86
6	Aug. 6 ?	11	.....	54	42	23.4	55	12.49	.....	15.92	1.068	55a
6	Aug. 28	13	.....	55	42	24	57	9.75	2.40	13.76	1.058	10b
6	Sept. 4	15	.....	67	55	31.1	56	10.49	.....	14.8b	1.058	47b
6	Sept. 19	17	.....	63	50	25.9	51	14.72	1.00	18.89	1.078	69c
6	Sept. 25	18	.....	84	64	30.5	47	14.01	.....	17.6b	1.071	4d
7	July 30	9	300 pounds Superphosphate... 150 pounds Kainit.....	20(?)	16(?)	15	.....	.....	2.33	14.51	1.056	23
7	Aug. 3	10	.....	47	39	18.1	46	.....	.....	13.45	1.057	46
7	Aug. 9	10	.....	41	32	19.4	60	10.58	1.55	13.78	1.056	87
7	Aug. 16 ?	12	.....	46	36	19.1	53	12.29	.....	16.31	1.068	54a
7	Aug. 28	14	.....	48	36	20.1	54	12.57	1.06	16.21	1.069	9b
7	Sept. 4	15	.....	58	46	24.9	54	12.99	.....	17.4 B*	1.073	48b
7	Sept. 10?	17	.....	71	55	29.4	53	15.14	1.22	19.2 B*	1.078	14c
7	Sept. 19	18	.....	56	42	22.2	52	14.43	1.27	18.84	1.074	70c
8	July 30	9	300 pounds Cotton Seed Meal	13(?)	10(?)	2.5	.....	.....	2.55	14.82	1.060	24
8	Aug. 9	10	.....	38	29	18.4	63	11.68	1.71	16.73	1.063	88
8	Aug. 16?	12	.....	51	40	22.1	55	12.31	.....	15.93	1.066	54d

*Brix.

Plot	Date.	Stage.	FERTILIZER, PER ACRE.	Weight Unstripped. Ounces.	Weight Stripped. Ounces.	Weight of Juice.	Per cent of Juice.	Per cent of Sucrose.	Per cent of Glucose.	Per cent of Total Solids.	Specific Gravity.	Analysis Number.
8	Aug. 28	14	.....	43	32	15.6	48	12.23	1.23	16.10	1.068	8 b
8	Sept. 4	15	.....	52	41	20.2	49	13.07	.....	17.6 B*	1.073	49 b
8	Sep. 10?	16	.....	46	37	19.9	43	14.48	1.35	18.6 B*	1.075	13 c
8	Sept. 19	17	.....	60	47	25.1	67	14.01	1.24	18.15	1.074	71 c
8	Sept. 25	18	.....	84	64	30.5	47	12.61	.....	17.6 B*	1.071	4 d
9	July 30	10	300 lbs. Cotton Seed Meal.... / 300 lbs. Superphosphate.....	18 ?	14 ?	11.5	41.0	.....	2.24	14.40	1.058	25
9	Aug. 9	10	.....	43	34	18.2	53.5	10.84	1.69	14.18	1.060	89
9	Aug. 16?	12	.....	48	37	19.4	52.4	12.49	.....	16.43	1.068	52 a
9	Aug. 28	14	.....	38	29	14	49.2	12.28	1.54	16.31	1.069	7 b
9	Sept. 4	16	.....	59	45	24.2	53.7	12.75	.....	17.2 B*	1.069	50 b
9	Sept. 10?	17	.....	58	46	24.9	54.0	14.60	1.05	19.4 B*	1.079	12 c
9	Sept. 25	18	.....	83	60	28.6	44.3	14.25	.....	19.2 B*	1.079	6 d
10	July 30	8	300 lbs. Cotton Seed Meal .... / 150 les Kainit	20 ?	16 ?	16	50.0	.....	2.35	14.32	1.052	26
10	Aug. 9	9	.....	45	35	21.6	60.1	9.21	1.99	12.42	1.054	90
10	Aug. 16?	12	.....	48	38	20.2	53.1	12.37	.....	16.25	1.066	51 a
10	Aug. 28	14	.....	44	36	16.9	46.4	13.61	0.99	17.44	1.070	6 b
10	Sept. 4	16	.....	52	43	24	55.8	12.88	.....	17.2 B*	1.070	51 b
10	Sept. 10?	17	.....	68	53	21.1	58.6	12.83	1.25	17.4 B*	1.072	11 c
10	Sept. 25	18	.....	96	74	38.2	51.6	12.76	.....	17.6 B*	1.071	7 d
11	Aug. 3	9	300 lbs. Cotton Seed Meal .... / 150 lbs. Nitrate Soda.....	32	28	12	43.8	.....	.....	14.73	1.059	47
11	Aug. 16?	11	.....	41	33	17.9	54.2	11.96	.....	14.17	1.064	50 a

*Brix.

Plot	Date.	Stage.	FERTILIZER, PER ACRE.	Weight Unstripped Ounces.	Weight Stripped Ounces	Weight of Juice.	Per Cent. of Juice.	Per Cent of Sucrose.	Per Cent of Glucose.	Per Cent of Total Solids.	Specific Gravity.	Analysis Number.
11	Aug. 28	13	.....	38	28	14.5	51.7	13.95	0.77	17.70	1.075	5b
11	Sep. 10	15	.....	63	50	27.2	54.4	13.76	1.15	18.4B*	1.075	10c
11	Sept. 25	16	.....	91	66	34.1	51.6	13.79	.....	18.4B*	1.072	8d
11	Oct. 2	18	.....	71	52	23.4	45.0	12.90	1.21	17.54	1.073	53d
12	Aug. 3	10	300 lbs. C. S. M.; 150 Superphosphate;. 150 Sodic Nitrate	41	32	15.1	47.1	.....	.....	15.09	1.061	48
12	Aug. 16	12	.....	44	33	18	54.5	12.24	.....	14.78	1.061	49a
12	Aug. 28	15	.....	38	27	14.5	53.7	13.90	0.81	17.62	1.074	4b
12	Sept. 10	17	.....	66	50	28.1	56.2	12.86	1.37	17.4B*	1.072	9c
12	Sept. 25	18	.....	78	56	27.5	49.1	12.78	.....	18.2B*	1.075	9d
13	Aug. 3	11	300 lbs. Acid Phosphate.....	36	28	10.5	38	9.41	.....	14.61	1.059	49
13	Aug. 16	13	.....	49	40	21.2	53	14.02	.....	14.59	1.060	48a
13	Aug. 28	15	.....	34	28	14.0	50	10.69	1.11	18.13	1.077	2b
13	Sept. 10	17	.....	57	46	23.65	57	12.54	2.20	15.4B*	1.067	8c
13	Sept. 25	18	.....	96	70	33.75	48	.....	.....	18.0B*	1.072	10d
14	Aug. 3	11	300 lbs. Acid Phosphate; 300 Cot. Sd. Meal	32	28	12	43	10.88	.....	12.28	1.063	50
14	Aug. 16	13	.....	36	27	13.4	49	14.02	.....	15.66	1.063	47a
14	Aug. 28	15	.....	34	28	14	.....	11.08	1.11	18.13	1.077	2d
14	Sept. 10	17	.....	53	40	20.4	51	.....	1.42	15.8B*	1.067	7c
14	Sept. 25	18	.....	70	51	26	51	.....	.....	19.0B*	1.076	11d

*Brix.

Texas Fever.

Texas, or Southern Cattle Fever, belonging, as it does, to the class of communicable diseases, has yet some peculiarities both in its origin and manner of propagation which distinguish it from most others of the class.

The virus of Texas fever has its home in the Southern States, in which regions, however, except as it affects imported cattle, the disease is almost unknown. It would seem that cattle born and raised in the midst of the infection of Texas fever, acquire immunity from its attacks, a condition which also to a more limited extent, occurs in Anthirax, a somewhat simi lar, if not identical disease. These cattle, although themselves healthy, carry with them the germs of the disease, and are thus the means of causing extensive outbreaks of Texas fever in northern districts through which they pass. The whole of Arkansas, with the exception of twelve counties in the north-eastern part of the State, is included in the region said to be permanently infected with the germs of Texas fever.

The proper location of the boundary line between the infected and non-infected regions of the State is a matter of the utmost importance in the prevention of outbreaks of this disease. The line, as laid out passes in a westerly direction through the northern part of the State, along the southern boundary of Mississipppi and Craighead counties, through Jackson, Independence, Stone, Searcy, Newton, Carroll and Benton counties, terminating at the extreme northwest corner of the last named county.

Some localities south of this are not dangerous, but are necessarily included in the infected region. If this boundary line be correctly located, then we must consider the native cattle of the twelve northern counties of Arkansas, (Mississippi, Craighead Greene, Clay, Randolph, Lawrence, Sharp, Izard, Fulton, Baxter, Marion and Boone), as susceptible to the germs of Texas fever. All parts of Arkansas south of this line are therefore dangerous to imported northern cattle.

A district once infected remains so until the germs are destroyed by the first frosts of winter. The conditions which render certain parts of the country permanently infected with the germs of Texas fever, as well as many other points in connection with the disease, have yet to be discovered, but sufficient is known to indicate to us the methods by which the danger of infection may be diminished.

The cattle native to the northeastern counties should be prevented from mixing with the cattle from further south or from passing over their trails. The neighborhood of a railroad should always be considered infected ground. Cattle brought from the North into Arkansas should be imported when young and in the winter months. In spring they should be isolated as far as possible from the native cattle and kept on dry upland pastures. Beyond attention to the general health no further measures have so far been found available in conferring immunity against the germs of the disease.

From the success of recent experiments in vaccination against anthrax it is probable that a preventive vaccine may also be found for Texas fever. Such a discovery would prove of the greatest advantage to the Southern States by allowing the importation of the best breeds of cattle, so essential to the improvement of our native stock, without the risk with which shipment from Northern States is now attended.

On the occurrence of the disease in any locality where the native cattle have not acquired immunity the healthy, but susceptible, animals should at once be removed from the sick and the latter quarantined, remembering that it is not the sick animals, but their surroundings—soil, vegetation, etc., that constitute the media of infection.

Cattle that die ought to be burned or buried deeply and disinfected with lime. No curative treatment is attended with much success. An aperient drench, followed by doses of anticeptics, as quinine or sodium hyposulphite, with stimulants in later stage, have sometimes proved successful.

Symptoms.

The symptoms of Texas fever that will be most obvious to the casual observer are, cessation of rumination and milk secretion (if in a milk cow), dryness of the muzzle, loss of appetite, discoloration of the mucous membrane of the eyes and nostrils, fever, arched back and drooping head, cough, increasing emaciation and weakness, bloody nasal and rectal discharge, urine brown or dark colored, thick and grumous; bowels irregular, increasing stupor, and death occurs often in convulsions.

The post-mortem appearances are usually characteristic. The fatty tissue is often of a yellow tinge, the mucous membrane of the true digestive stomach more or less congested, spleen enlarged, softened and infiltrated with dark colored

fluid; liver enlarged, gall bladder distended, kidneys usually altered in appearance and the bladder full of red or dark colored urine.

More exact knowledge as to the mode of propagation and districts permanently infected should lead to the establishment of restrictive laws on the movement of cattle and largely reduce the ravages from this disease.

The Station invites correspondence and will be ready to answer any questions in connection with veterinary science from agriculturists of this State.

Besides the Bulletins issued giving an account of the experimental work completed and of sufficient importance to warrant publication, some of the other work performed may be briefly referred to. A large part of the time has been occupied in Bacteriological work. chiefly with the common non-pathogenic organisms for the purpose of becoming familiar with these forms and of thus obtaining practical skill in the technique necessary for successful work in Bacteriological pathology, which field more than any other promises success in the investigations of epidemic diseases.

Several outbreaks of contagious diseases more or less extensive have been investigated and identified, but, on the whole, such diseases of live stock in this State have neither been common nor wide spread.

Swine Plague has prevailed in some localities. In those outbreaks which were observed the manner in which the animals were kept running out in the woods, and the disregard of any measures for isolating the sick on account of the extra trouble involved, resulted in the disease being allowed to take its course.

Texas Fever has been heard of only in one or two cases and even these were doubtful. Perhaps the most frequent cause of complaint has been the numerous deaths among cattle in the fall from a disease often called "Dry Murrain." It occurs among cattle that are pastured on the ranges or commons where the grass at this season is, much of it, dry and innutritious. In several cases of this kind where post-mortem examinations were made the only abnormal conditions found were impaction, generally complete and solid, of the third stomach. Brain symptoms were sometimes exhibited before death. The hardened and dry contents of the manyfolds were found to consist of the grasses and seeds common on these ranges wedged in between the muscular folds. Such cases usually occur in animals which have to depend on these scanty pastures alone for

their food. By supplying a certain amount of nutritious food at this time as an auxilliary to pasturage the danger of this condition would be much lessened.

Among diseases of horses which have been observed mention will be made of an outbreak at Goodwin, St. Francis county, which though not wide spread, was from various causes extremely fatal on those farms on which it was found. There was no difficulty in identifying the disease and giving it a name. It was a severe form of the disease known as "Strangles" or "Distemper," or since the latter term is used somewhat indefinitely it may perhaps be more properly called Suppurative Fever. Fever and the formation of abscesses are the prominent symptoms.

The outbreak was investigated at the request of Mr. B. Manning, of Goodwin, the largest stock raiser in that district, on whose farm it chiefly showed itself. It was supposed by many of the neighbors to be Glanders, although all the characteristic symptoms of that disease were absent. The record of Mr. Manning's losses as recorded by himself at this date, December 27th, the disease having now subsided, is given here.

When the disease first appeared there were on the farm thirty-one horses of all ages. The effect of the disease was as follows:

Age.	Affected.	Died.	Recovered.	Escaped.
Adults	9	5	4	6
Two years	1	1	—	3
One year	4	4	—	1
Suckling colts	6	3	3	1
Totals	20	13	7	11

From this table it is seen that horses of all ages were attacked indiscriminately although all of the older animals had previously suffered from distemper in its ordinary benignant form. It has usually been supposed that one attack of distemper confers almost complete immunity against future attacks. Three or four others whose farms adjoined Mr. Manning's also suffered more or less. Beyond that immediate locality, however, there was not nor had been any disease. This limitation of the outbreak may have been due either to the fact that the district was to a certain extent quarantined by those around

who suspected the disease to be Glanders, or on account of the cause being itself thus localized—a true enzootic disease. Until the cause has been discovered such questions cannot be answered. There was a possibility of transmission by contagion in all the cases found but no direct evidence to show that this was the case.

The first case was examined August 25th. It was a brood mare seven years old and had previously suffered from distemper. The symptoms were as follows, taken from notes: Swelling under jaws, chiefly on left side, which had first appeared six days before. It had been opened early before matter had formed. There was now a discharge of pus from a small opening with general tumefaction of the throat. No cough, dyspnœa, or nasal discharge; appetite fair, and bowels regular. Pulse 52; temperature 102-3° F.

August 28th. Another abscess has formed further up near the angle of the jaw. After this was opened the mare continued to improve till recovery. Several others exhibited similar symptoms, but the abscesses were sometimes found on neck and shoulder. The cases that were seen early showed first some dullness and loss of appetite, followed by high fever with a temperature as high as 105° F, and increasing tumefaction of the throat. These symptoms do not differ widely from those seen every year during the attacks of distemper. The excessive mortality in this case is contrary to the general experience and must be attributed to some cause other than the disease itself. Many of these horses died out on the range and some of them suddenly, but as there was no opportunity of holding post-mortem examinations the immediate cause of death could not be determined. The most important points in the treatment are good attention and shelter and in proportion as these are neglected the mortality increases. One of these cases exhibited high fever and the other symptoms of the disease without any visable abscess formation and by proper treatment made a good recovery, while another exhibited intense and prolonged fever which ultimately terminated fatally, with but slight suppuration. Both of these cases were most probably due to the generalization of the poison through the system. All the others presented symptoms such as are usually seen in the regular form of "Strangles." The treatment recommended consists in good nursing and shelter, simple febrifuge medicines, and evacuation of the pus when formed by free incisions. Blistering the tumor when indolent, hastens its maturation.

In cases where the fever was very high quinine in dram doses twice daily had a marked effect in reducing it.

Strangles or distemper is a disease that has been known for ages, but its cause has never been discovered. To say that it is due to some impurities or morbid condition of the blood seeking exit through external abscesses is the popular because the easiest way of getting out of the difficulty. The pathology of the present day, however, shows us in what direction to look for its causation. Like all other diseases of this kind it is undoubtedly a microbic disease having for its cause a vegetable fungus. Such diseases are always more or less contagious or at least capable of being transmitted by inoculation, and neither of these points have ever been satisfactorily determined in regard to strangles. Simple observation of a disease as it occurs naturally is always an unreliable method of determining its contagiousness and thus far has proved inadequate to satisfy us in regard to distemper.

If, then, the disease could be artificially produced by inoculation or by indigestion of the morbid materials derived from a sick animal two points would be gained. In the first place it would be proved that it was, if not generally spread by contagion, at least capable of being transmitted in that way, and, as a consequence of this, we should infer that it was parasitical, or, speaking more definitely, a bacterial disease.

The following experiment was undertaken with the view of contributing something to the elucidation of these points.

Two horses were procured from a gentleman in Goodwin, Mr. T. Hill, for experimental purposes. They had been pastured four or five miles from the nearest infected animals had not been exposed, and had never previously suffered from distemper. It should be said that they belonged to the Texas stock which is, perhaps, less susceptible to distemper than most others but these were the only kind that could be obtained. They arrived at Mr. Manning's farm August 26th. The result of this experiment in each case is condensed from notes.

No. 1. A small three year old mare was examined on arrival and found healthy. Pulse 52; respiration 18; temperature 100.8. Placed in stall formerly occupied by distempered horses, and sick animals now allowed free access to her. Watered from deep well water.

August 31. In usual health; drenched with about four drams of pus mixed with six ounces of water just taken from a newly opened abscess of a mare suffering from the disease.

This was the second abscess that had formed in the intermaxillary space. The mare was then returned to the same stall. Pulse was then 32, and temperature 100.5.

The mare was examined daily for over a week without showing any abnormal smyptoms and at the end of two weeks was reported healthy and turned out with the other horses where she remained a month without contracting disease. She was then returned to owner. Ingestion of the pus, which might be supposed to contain the virus, did not in this case prove successful.

No. 2. Small colt, two and a half years old, had been running on pasture with No. 1 arrived August 26; examined and found healthy. Glands in intermaxillary space were somewhat enlarged, but not tender or inflamed. This condition is often found in colts without any indication of disease. Pulse 50; respiration 15; temperature 102.2.

Inoculated in breast and behind elbow with pus and blood (mixed with pure water), obtained from the same source as in the case of No. 1. About one dram of the mixture, containing twelve drops of the pus, were injected under the skin, and half a dram of the pus was rubbed on the nasal septum. The colt was then placed in a shed by itself, away from all the others, and where sick horses never had access to. August 27th. Points of injection swollen but no fever. 28th and 30th. Health as usual. 31st. Swellings large, broad and tender, meeting each other between the arms, but no increase in temperature or constitutional symptoms. Pulse 42; respiration 14; temperature 100.8° F. September 2nd. Pus oozing from openings of needle track. Abscesses were opened and cavities syringed with carbolic lotion. General health as usual. September 8th. Reported to be in usual health, but the abscesses behind the arm suppurating afresh and requiring to be again opened. The suppurating continued and the swelling spread along the abdomen and up the breast, but the appetite remained good. There was never any appreciable rise of temperature.

October 15th. On second visit to Goodwin, the colt No. 2 was found to have fallen off greatly in flesh with large tumors on breast and behind elbow, each discharging at several points. These were thoroughly opened but suppuration still continued with increasing emaciation till December 27th, when the animal was reported dead. Before death there was partial loss of power in the fore limbs. There was no post-mortem examina-

tion, but Mr. Manning, who opened up suppurating tracks found them only of small extent, and not deep seated.

This experiment cannot be considered as entirely satisfactory on account of the absence of any marked constitutional symptoms and the limitation of the abscesses to the seat of inoculation. It is certain, however, that the material used for inoculation contained a virus more virulent than that of ordinary pus, which would not have produced such extensive suppuration. The specific microbe contained in the pus, no doubt, multiplied and spread locally, but it did not become absorbed into the general circulation except probably till near the last. Part of the pus used for inoculation collected in vacuum tubes and examined under the microscope one week later showed the presence of bacterial forms. Cultivations in beef infusion at 38 C., gave pure cultures of micrococci evident on staining. They occurred single, in pairs, and in groups and short chains. The same forms were obtained by cultures from the pus derived from the abscesses resulting from this inoculation. On account of the absence of material, inoculation of other animals with the culture fluids was not attempted.

This experiment is not advanced as conclusive, but so far as it goes, it favors the theory of the Bacterial origin of the disease and its capability of being communicated by contagion. The fact that a disease can be so communicated does not, however, show that it usually spreads in that way. The history of outbreaks of distemper rather indicate the presence of the specific poison in the surroundings, food, air or water, which having thus gained entrance into the system multiply there and localize themselves principally in the submaxillary lymphatic glands. All the animals affected in this outbreak were running out on the range and drinking from the stagnant water found in ponds there, and the water would naturally suggest itself as being the source of the poison. Such water examined microscopically was found to contain several forms of bacterial life including micrococci, but the question of their identity with the organisms found in the pus of distemper cannot be determined by resemblance in form. It is certain that the disease subsided when the horses were brought up from the range and watered from the well, and again broke out when they were put back on the range. The season had been unusually wet, but whether that had any influence in the development of the virus is problematical.

Recent experiments by Dr. Shutz with Strangles as it occurs in Germany confirm the theory of its Bacterial origin. He describes the organisms found among the pus corpuscles as micrococci occurring in chains, (streptococci) and in pairs (diplococci). Inoculation experiments proved successful in inducing the disease in colts, producing both the local abscesses and the constitutional symptoms. He also states that the virus may be localized or become generalized and produce a form of blood poisoning with multiplied abscesses. These statements are confirmatory of the observations made in this investigation. Although such experiments may seem to many unnecessary because not leading to any immediate practical results, they are nevertheless on the lines in which all investigations of the cause of epidemic diseases, must be directed in order to come at a true understanding of their nature and treatment.

COTTON.

This plant, of so much importance to Arkansas, has necessarily claimed a great deal of our attention and we have made a number of experiments with respect to cultivation, fertilizers, etc., in different sections of the State. We were particularly anxious to do this, for it secures a multiplication of answers to the same question, and it is always safer to base conclusions and generalizations upon such data. As our readers are well aware, it takes usually about fifteen hundred pounds of seed cotton to produce five hundred pounds of lint. This means about *two and one-quarter tons* of vegetable matter to the acre. This immense amount of substance has to be furnished in some way; fortunately some of our lands are still with enough to supply what is needed, but the great bulk of them that have been in cultivation for many years are rapidly becoming worn out, the result is obvious, as the land becomes poorer the yield is certainly bound to become less. Here is where the necessity for making experiments with artificial fertilizers arises. We must determine what is lacking in the soil by field experiments, and the greater number of experimental centres the more benefit is certain to follow. We do not believe in analyzing a soil and then writing a prescription. It is popularly supposed that this is our work, this is a great mistake for in extremely rare instanceshave agricultural chemists been able to separate the ingredients of a soil in such a manner as to determine exactly

the condition that they existed in previous to an analytical determination. Most cotton lands are lacking in potash, nitrogen and phosphorus. It is therefore, our endeavor to determine in what form, what proportion, whether alone or in mixture these substances should be applied. If the planters would make the proper use of the products of his crop, he would not need so much outside aid. The sale of cotton seed without the return of any equivalent is not the money making process that it seems to be. It is all very well for those men who rent the land to get all they can out of it without any return, but for the actual owner it is a ridiculously short-sighted policy. If you sell your seed, buy commercial fertilizers with part of the proceeds at any rate. If you wish to conduct the business on business principles, have some stock, feed them one of the products of your cotton seed, namely: *cotton seed meal.* Abroad the manure from a ton of cotton seed meal is considered worth $2.50 *more* than the meal cost. The stock takes away from the meal what is necessary for their support and in the manure will be found those substances that are readily asimilated and needed by plants. Don't feed the meal alone, mix it with some other foodstuff not as rich. What becomes of the cotton seed under the present circumstances? Outsiders make the money out of it. The planters will find that each year, unless he has phenomenally rich land his yield will decrease under the common methods generally in vogue. The Trust sell your oil probably to make foodstuffs. The cotton seed meal is sold for the manufacture of commercial fertilizers since it contains a high percentage of nitrogen, and is also largely purchased by cattle feeders here and abroad. Yes, sell your cotton seed, but after the oil is out either feed the meal or buy some kind of fertilizers for your land, which cannot give forever without some kind of return. We firmly believe that by the addition of the stock raising industry to the ordinary business of planting, a true, economic basis may be reached, which will make cotton planting a more profitable occupation than when the ancient, non-progressive custom is followed, that seems in many instances to be but a method of enriching the merchant at the expense of the planter.

Description of Cotton Varieties.

Crawford—Early, prolific, fine staple, easy to pick, short linted, considered one of the very best upland varieties yet introduced; stands drouth well.

Peterkin—Hybrid, between Sea Island and Carolina Upland. Small seed, some of them black; gives a larger yield of lint from a given quantity of seed than almost any other variety; it is well suited to upland, stands drouth; staple as good as some, finer than ordinary.

Hawkins—Similar to Crawford, but a taller grower, longer branches and larger bolls.

Ozier Silk—Very fine staple, a hybrid, between Upland Herlong and Sea Island, a tall grower, moderately prolific, best suited to low country.

Peerless—This seems to us to be identical with the Crawford, except that the Peerless sells for ten dollars a bushel and Crawford for two and a half.

Jones—The seed of this variety was mixed; we thought that we were safe in dealing with a well known firm; they will however, no longer handle the seed, as they are afraid of having common seed shipped to them.

Mr. Cory s Experiment on Cotton at Pine Bluff.

PART I.

I. Object: To test the effect of different fertilizers.

II. Preparation of soil; broken up broadcast with a Sulky Plow. The rows were laid off three and a half feet wide by seventy yards long. Fertilizers were applied in the furrow with a Banner planter, and covered with a bed thrown up with a half shovel.

III. Arrangements: Six rows equal to one-tenth acre were devoted to each experiment:

	Yield per Acre.
Plat No. 1—30 lbs. cotton seed meal	645
" 2—35 lbs. Superphosphate	440
" 3—35 lbs. Kainit	490
" 4— 8 lbs. Muriate of Potash	420
" 5—10 lbs. Am. Sulphate	550
" 6—Blank	375
" 7—30 lbs. C. S. M., 30 lbs. Sup	800
" 8—30 lbs. C. S. M., 30 lbs Sup., 8 lbs. Muriate	770
" 9—18 lbs. Sup., 8 lbs. Mur., 5 lbs. Am. Sul	660
" 10—30 lbs, C. S. M., 8 lbs. Mur	685
" 11—Blank	530
" 12—1 ton barn yard manure	680

	Yield per Acre.
Plat No. 14—160 lbs. Ga. and Ala. Compost, =40 lbs. Acid Phos., 60 lbs. C. S., 60 lbs. stable manure	665
" 15—160 lbs. Furman's Compost,=26 ⅔ lbs. Acid Phos., 13⅓ lbs. Kainit, 60 lbs. C. S., 60 lbs. sta. manure	680
" 16—160 lbs. M. C. Compost, =64 lbs. Acid Phos., 16 lbs. Kainit, =48 lbs. C. S., 32 lbs. stable manure	625
" 17—160 lbs. S. C. Compost No. 4, =60 lbs. Acid Phos, 28 lbs. Kainit, 48 lbs. C. S., 24 lbs. stable manure	500
" 18—160 lbs. S. C. Compost No. 6, =60 lbs. Floats, 28 lbs. Kainit, 48 lbs. C. S., 24 lbs. Stable Manure	495
" 19—160 lbs. S. C. Compost No. 7, =60 lbs. Acid Phos., 28 lbs. Kainit, 72 lbs. C. S.	570
" 20—160 lbs. S. C. Compost No. 8, =60 lbs. Floats, 28 lbs. Kainit, 72 C. S.	620
" 21—160 lbs. Cotton Seed	490
" 22—160 lbs. S. C. Comp. No. 5, =80 lbs. C. S., 80 lbs. Sta. Ma.	285
" 23—Blank	255
" 24—25 lbs. Cotton Seed Hull Ashes	355

A good stand was secured on all plats; but on 21, 22 and 23 the cotton died out before chopping. The soil is very sandy on these plats, and this is probably the cause of the dying out. The stand was not so defective on 21 and 24 as on 22 and 24.

The plats from 1 to 6 are nearly equal in fertility, and the soil similar. From 6 to 11 there is a uniform increase in fertility, the soil changing from a sandy loam to a brown clay loam. From 11 to 21, the soil is nearly uniform in fertility. At No. 23 the brown clay loam begins to shade into the sandy.

The yield of Nos. 12 and 13 was reduced by a wash. The yield of Nos. 16, 17 and 18 slightly reduced by a wash at one end.

General Remarks.

The effect of fertilizers on the size of the plant, in all plats except No. 3, fertilized with superphosphate, was very marked, the advantage of the fertilized over the unfertilized being evident from the time of chopping out. The difference in size very slight at first, uniformly increased up to August 1st, when some of the fertilized plats were fully 12 inches taller than those not fertilized.

The plat with 2 tons barn yard manure had the advantage in size from the beginning. The plats combining nitrogen,

potash and phosphoric acid were nearly as large as this. The cotton seed meal only, and ammonium sulphate plats, were larger than those on either side. The ammonium sulphate plat had better color than any other. The compost plats were about equal in size with slight differences in color.

The effect of potash whether used alone or mixed with other fertilizers, seems to have been, to give the plant a yellowish tinge. The dry weather between the 18th of July and the 15th of August checked the growth of cotton.

Caterpillars destroyed the foliage of the plant between the 1st and 5th of September. When the foliage was destroyed the blanks and compost were still growing, but the other plats seemed to be at a stand. It would seem from this, that the blanks and compost plats were injured more by the caterpillar than those plats which were more mature.

Cultivation.

Owing to the lateness of the season at which the fertilizers could be obtained the composts stood in the heap a shorter time than is usual. They were applied in the drill on the 9th of May, the land bedded at once, and the cotton planted on the 11th. No stand was secured from first planting, and on the 21st the land was planted again. The banner planter was used. Two bushels of Peterkin seed were used at each planting.

The failure to get a stand at first planting, was probably caused by putting the seed in too deep. A good stand was secured by June 3rd.

June 5th. Sided with an 18-inch solid sweep. Chopped out between the 5th and 10th of June. Hills were left from 10 to 18 inches apart, with not more than three stalks to the hill.

June 11th to 14th. Sided with an 18-inch solid sweep. June 20th. First five plats and one-half of the sixth hoed. June 21st and 22d. Heavy rains. June 25th and 26th. Remaining plats hoed.

July 4th and 5th. Sided with an 18-inch solid sweep. July 9th. Middles thrown out with 22-inch solid sweep. July 16th and 17th. Sided with an 18-inch solid sweep. July 21st. Middles thrown out with a 22-inch solid sweep. July 24th. Hoed. July 25th. Sided with a 22-inch solid sweep on evening of 25th and morning of 26th. Middles thrown out with same sweep on the evening of the 26th. In plowing the sweep was always set flat, the idea being to throw as little dirt as possible.

Table showing the weight of Cotton obtained at each picking:

Date of Picking.	Yield Pounds.	Fertilizers Used. Lbs. pr. acre	Equals acre yield of lbs. Seed Cotton.	Date of Picking.	Yield Pounds.	Fertilizers Used. Lbs. pr. acre	Equals acre yield of lbs. Seed Cotton.
Sept. 26 ...	34	300 lbs. Cotton Seed Meal.	645	Sept. 26...	17	80 lbs. Muriate.	420
Oct. 27.....	28			Oct. 18...	27		
Nov. 24 ...	2½			Nov. 23...	7		
Sept. 26...	16	350 lbs. Kainit.	490	Sept. 25...	14	Blank.	375
Oct. 26.....	27			Oct. 19...	18		
Nov. 24 ...	6			Nov. 23...	5½		
Sept. 26...	26	100 lbs. Ammonium Sulphate.	550	Sept. 25...	45	300 lbs. Cotton S'd Meal, 300 lbs. Superphos., 80 lbs. Muriate.	800
Oct. 19.....	23			Oct. 20...	30		
Nov. 23 ...	6			Nov. 23...	5		
Sept. 25...	39	300 lbs. Cotton Seed Meal, 300 lbs. Superphos'te	770	Sept. 25...	34	300 lbs. Cotton Seed Meal. 80 lbs. Muriate.	685
Oct. 19.....	31			Oct. 20...	29		
Nov. 23...	7			Nov. 23...	5½		
Sept. 25...	32	180 lbs. Superphos., 80 lbs. Muriate, 50 lbs. Am. Sulphate.	660	Sept. 25...	33	1,600 lbs. Furman's Formula.	680
Oct. 20.....	28			Oct. 25...	29		
Nov. 23 ...	6			Nov. 23...	6		
Sept. 25...	21	Blank.	530	Sept. 25...	22	1,600 lbs. S. C. Compost No. 4.	500
Oct. 24.....	28			Oct. 25...	24		
Nov. 23 ...	4			Nov. 23...	4		
Sept. 25...	33	1,600 lbs. Ga. and Ala. Compost.	665	Sept. 25...	25	1,600 lbs. S. C. Compost No. 7.	570
Oct. 25.....	31			Oct. 26...	29		
Nov. 23 ...	2½			Nov. 23...	3		
Sept. 25...	29	1,600 lbs. N. C. Compost.	625	Sept. 26...	16	1,600 lbs. Cotton Seed.	490
Oct. 25.....	28			Oct. 26...	31		
Nov. 23 ...	5½			Nov. 24...	2		
Sept. 25...	17	1,600 lbs. S. C. Compost No. 6.	495	Sept. 26...	9	1,600 lbs. S. C. Compost No. 5.	285
Oct. 25.....	29½			Oct. 26...	18		
Nov. 23 ...	3			Nov. 24...	1½		
Sept. 26...	28	1,600 lbs. S. C. Compost No. 8.	620	Sept. 26...	7	Blank.	255
Oct. 26.....	32			Oct. 26...	17		
Nov. 23 ...	2			Nov. 24...	1½		
Sept. 26...	17	350 lbs. Superphosphate.	440	Sept. 26...	9	250 lbs. Cotton Seed Hull Ashes.	355
Oct. 27.....	24			Oct. 26...	23		
Nov. 24 ...	3			Nov. 24...	3½		

The following are the formulas for the manufacture of the various composts commonly used:

Georgia and Alabama Compost.

600 pounds Cotton Seed.
600 pounds Stable Manure.
400 pounds Acid Phosphate.

Furman's Formula.

262 pounds Superphosphate.
131 pounds Kainit.
600 pounds Cotton Seed.
600 pounds Stable Manure.

North Carolina Compost.

640 pounds Superphosphate.
160 pounds Kainit.
480 pounds Cotton Seed.
320 pounds Stable Manure.

South Carolina No. 4.

600 pounds Superphosphate.
280 pounds Kainit.
480 pounds Cotton Seed.
240 pounds Stable Manure.

South Carolina No. 5.

800 pounds Cotton Seed.
800 pounds Stable Manure.

South Carolina No. 6.

600 pounds Floats.
280 pounds Kainit.
480 pounds Cotton Seed.
240 pounds Stable Manure.

South Carolina No. 7.

600 pounds Superphosphate.
280 pounds Kainit.
720 pounds Cotton Seed.

South Carolina No. 8.

600 pounds Floats.
280 pounds Kainit.
720 pounds Cotton Seed.

Method for Preparing Composts.

Spread the barn yard manure on a level place under cover (say twenty bushels), then spread over it two hundred pounds of acid phosphate, then over this put twenty bushels of wet cotton seed; now put on barn yard manure, acid phosphate and cotton seed in the same proportions as before until all that you may wish to make is mixed. Cover the heap with about four inches of soil. Allow it remain for from four to six weeks, when ready for use cut vertically. This method is applicable for the manufacture of any of the preceding composts. The ingredients of course being changed as per formula.

TESTS OF VARIETIES.

Object—To test the productiveness of different varieties.

Preparation of soil—Arrangements and cultivation substantially the same as that for fertilizing experiments. Plots of one-fifth acre each were used for the various varieties:

VARIETY.	DATE OF PICKING.	YIELD.	EQUALS ACRE YIELD OF POUNDS	VARIETY.	DATE OF PICKING.	YIELD.	EQUALS ACRE YIELD OF POUNDS
	Sept. 24	82			Oct. 12	33	
Allen.....	Oct. 9	36	775	Peterkin*....	Nov.	18	255
	Nov.	37					
	Sept. 25	78			Sept. 24	71	
Ozier Silk.	Oct. 10	31	665	Jones.....	Oct. 12	32	605
	Nov.	22			Nov.	18	
	Sept. 24	42			Sept. 24	63	
Crawford.....	Oct. 12	34	420	Peerless	Oct. 18	36	470
	Nov. 24	8			Nov. 24	5½	
	Sept. 24	48					
Hawkins....	Oct. 18	39	510				
	Nov. 24	15					

*Vitiated by difference in time of planting.

These varieties were planted on the 28th of April, Peterkin excepted, being planted May 5th. Peterkin planted the second time May 21st.

May 22d. Sided with an 18-inch solid sweep.

June 4th. Chopped out, stalks left about eighteen inches apart in the drill.

June 6th. Sided with an 18-inch solid sweep.

June 18th and 19th. Hoed. June 19th. Sided with an 18-inch solid sweep.

July 6th. Sided with an 18-inch solid sweep.

June 30th. Middles thrown out with solid sweep.

July 9th. Middles thrown out with 22-inch solid sweep. Hoed between the 18th and 21st of July.

July 21st. Sided with an 18-inch solid sweep.

July 23d. Middles thrown out with a 22-inch solid sweep.

Record of Rains During the Summer.

May 31st. Heavy rain.
June 1st. Heavy rain.
From June 1st to 21st Showery.
June 21st. Heavy rain.
June 22d. Heavy rain.
July 6th. Rain enough to wet the soil.
July 7th. Light showers.
July 9th. Heavy rain.
July 17th. Heavy rains; showers between 9th and 17th.
July 18th. Heavy rain.

August 15th. Showers interspered with heavy rains between August 15th and September 1st.

There were three weeks of dry weather in May, succeeded by heavy rains on the 31st of May and 1st of June.

The greater part of September and October were dry and favorable to cotton picking.

November was very damp and unfavorable to picking.

Col. A. G. Jarman's Experiments at Barton, Phillips Co.

The land used in these experiments is of full average quality for this section, very slightly sandy, clay sub-soil, was well prepared, fully pulverized, and planted first week in May. Fertilizers put in laying off furrows and bedded on it. Up to August 17th the prospect was most flattering, on that day we had a severe storm which leveled the stalks with the ground and whipped the fruit off. All experiments were made on one-tenth acre plots.

VARIETY.	FERTILIZER USED, POUNDS PER ACRE.	YIELD POUNDS SEED COTTON PER ACRE.	YIELD POUNDS LINT PER ACRE
Jones' Improved	100 pounds Acid Phosphate	550	180
Ozier Silk	100 pounds Kainit	560	190
Crawford's Improved	25 pounds Chloride Potash	850	260
Hawkins	50 pounds Sodic Nitrate	830	260
Peerless	35 pounds Ammonium Sulphate	830	270
Peterkin	100 pounds Cottton Seed Meal	850	310
Peterkin	100 pounds Acid Phosphate 100 pounds Cotton Seed Meal	950	350
Peterkin	100 pounds Acid Phosphate 100 pounds Cotton Seed Meal 25 pounds Potash Chloride	1170	450
Allen	100 pounds Acid Phosphate 25 pounds Potash Chloride	900	250
Shine's Early	100 pounds Cotton Seed Meal 25 pounds Potash Chloride	830	260
Shine's Early	250 pounds Salt 250 pounds Hard Wood Ashes	1060	320

Mr. W. P. Hale's Experiments at Lufra, Ouachita County.

Parts of an acre used one-twentieth. The crop was planted May 15th. This was rather late, but through various causes was unavoidable. It would have yielded a fine crop but for the very wet June and part of July, followed by continued dry, hot weather up to September 27th.

The object of these experiments was to determine the effect of various fertilizers on the yield. The following results were obtained:

QUANTITY OF FERTILIZER USED PER ACRE.	YIELD POUNDS OF SEED COTTON.
200 pounds Acid Phosphate	680
200 pounds Kainit	600
50 pounds Chloride of Potash	480
100 pounds Sodic Nitrate	400
70 pounds Ammonium Sulphate	480
200 pounds Cotton Seed Meal	480
200 pounds Cotton Seed Meal 200 pounds Acid Phosphate	800

200 pounds Acid Phosphate... 200 pounds Cotton Seed Meal 50 pounds Potash Chloride...	800
200 pounds Acid Phosphate... 50 pounds Potash Chloride.	720
200 pounds Cotton Seed Meal 50 pounds Potash Chloride...	600
Nothing	440
Nothing	480

Mr. F. M. Bordeaux's Experiments at Monticello, Drew Co.

Parts of an acre used one-twentieth. The crop was planted April 19th. Shines Prolific being used. The following method of cultivation was adopted. The land flat broke, then laid off three and one-half feet between the rows with six-inch shovel and fertilizers put in the drill and bedded in, then the harrow run over beds before the planter. Put one bushel of seed to the acre. May 16th, scraped with Mitchell scraper and blocked out with hoe two to four stalks in hill fifteen inches apart in drill. May 24th, dirted up with fourteen-inch heel sweep. June 7th, put to stand one stalk in hill about fifteen inches in drill. June 15th, run around second time with fourteen-inch heel sweep. June 26th, first bloom. June 28th, run around with eighteen-inch heel sweep. July 10th, run middle out with eighteen-inch sweep *shallow*. Results below:

QUANTITY OF FERTILIZER USED PER ACRE.	YIELD LBS. OF SEED COTTON PER ACRE.
200 pounds Acid Phosphate.	700
200 pounds Kainit	600
50 pounds Chloride Potash	620
100 pounds Sodic Nitrate	720
70 pounds Ammonia Sulphate	600
200 pounds Cotton Seed Meal	860
200 pounds Cotton Seed Meal 200 pounds Acid Phosphate...	800
200 pounds Acid Phosphate... 200 pounds Cotton Seed Meal 50 pounds Chloride Potash...	980
200 pounds Acid Phosphate... 50 pounds Chloride Potash..	920
200 pounds Cotton Seed Meal 50 pounds Chloride Potash ..	1000
Nothing	540

A further set of experiments were made as follows: One acre with Stearns' raw bone superphosphate. Rows three and a half feet apart, furrow run in middle of row with eight-inch shovel, fertilizers applied in drill and bedded on April 13th, two hundred and twenty pounds per acre April 19th, planted with Peterkin seed one bushel per acre, cultivated the usual way, being scraped with Mitchell scraper and being put to a stand by June 6th, cultivated with heel-sweep, all the time shallow up to July 7th, when cultivation ceased. Yield on one acre 1,502 pounds seed cotton.

One acre fertilized with cow lot manure, one hundred pounds acid phosphate and fifty pounds German kainit in every ton composted. Three tons of the compost applied to every acre, one-half broadcast and one-half acre in drill. Rows three and one-half feet apart cultivated with heel-sweeps after being scraped and hoed, cultivation shallow, cultivation finished July 7th. Yield one-half acre broadcast 734 pounds seed cotton, one-half acre manure in drill, 809 pounds seed cotton. One acre fertilized with stable manure, cotton seed thirty bushels to the ton with one hundred pounds acid phosphate and fifty pounds German kainit in every ton composted. Applied in drills three tons per acre and bedded on in rows four feet apart April 12th. April 19th, planted with Peterkin seed, one bushel per acre, after being scraped and hoed, cultivated heel-sweep shallow until July 7th. Total yield per acre 2,128 pounds seed cotton. Mr. Bordeaux believes that the yield would have been better with one ton of compost per acre. He also thinks that the reason the half acre manured broadcast did not yield as much as the half acre in the drill was owing to the drouth during the latter part of July and first of August, which caused it to throw off worse on account of the manure being near the surface, which was plain even to a casual observer during that period. Unfertilized cotton on this land averaged 760 pounds seed cotton per acre.

Further discussion of composts and these results will be found in the account of general results on cotton fertilizers.

VARIETY.	POUNDS OF FERTILIZER PER ACRE.	EXPERIMENTER.	LOCATION.	YIELD POUNDS SEED COTTON PER ACRE.	YIELD POUNDS LINT PER ACRE.	VALUE OF INCREASE AT 9c. PER POUND.	COST OF FERTILIZERS.	PROFIT PER ACRE.	LOSS PER ACRE
Moon	300 Acid Phosphate	J. K. Fitzgerald	Texarkana	850	270	$10.62	$1.95	$8.67	
Peterkin	200 " "	F. M. Bordeaux	Monticello	700	233	4.73	1.30	3.43	
Moon	200 " "	W. P. Hale	Lufra	680	227	6.76	1.30	5.46	
Jones	100 " "	A. G. Jarman	Barton	550	180	45	65		20
Peterkin	350 Kainit	A. F. Cory	Pine Bluff	490	163	3.42	2.10	1.32	
Moon	300 "	J. K. Fitzgerald	Texarkana	640	220	6.12	1.80	4.32	
Peterkin	200 "	F. M. Bordeaux	Monticello	600	200	1.80	1.20	60	
Moon	200 "	W. P. Hale	Lufra	600	200	4.23	1.20	3.03	
Ozier Silk	100 "	A. G. Jarman	Barton	560	190	1.35	60	75	
Peterkin	80 pounds Chloride Potash	A. F. Cory	Pine Bluff	420	140	1.35	1.80		45
Moon	60 " " "	J. K. Fitzgerald	Texarkana	710	240	7.92	1.35	6.57	
Peterkin	50 " " "	F. M. Bordeaux	Monticello	620	207	2.43	1.13	1.30	
Moon	50 " " "	W. P. Hale	Lufra	480	160	63	1.13		50
Crawford	25 " " "	A. G. Jarman	Barton	850	260	7.65	57	7.08	
Peterkin	100 pounds Sodic Nitrate	F. M. Bordeaux	Monticello	720	240	5.40	3.00	2.40	
Moon	100 " " "	W. P. Hale	Lufra	400	133		3.00		4.80
Hawkins	50 " " "	A. G. Jarman	Barton	830	260	7.65	1.50	6.15	
Peterkin	100 pounds Ammonic Sulphate	A. F. Cory	Pine Bluff	550	183	5.22	3.50	1.72	
Moon	80 " " "	J. K. Fitzgerald	Texarkana	740	250	8.82	2.80	6.02	

VARIETY.	POUNDS OF FERTILIZER PER ACRE.	EXPERIMENTER.	LOCATION.	YIELD POUNDS SEED COTTON PER ACRE.	YIELD POUNDS LINT PER ACRE.	VALUE OF INCREASE AT 9c. PER POUND	COST OF FERTILIZER.	PROFIT PER ACRE,	LOSS PER ACRE.
Peterkin	70 pounds Ammonic Sulphate	F. M. Bordeaux	Monticello	600	200	$ 1.80	$2.45		$ 65
Moon	70 " " "	W. P. Hale	Lufra	480	160	63	2		1.82
Peerless	35 " " "	A. G. Jarman	Barton	830	270	8.55	1.23	$7.32	
Peterkin	300 Cotton Seed Meal	A. F. Cory	Pine Bluff	645	215	8.10	1.95	6.15	
Moon	250 " " "	J. K. Fitzgerald	Texarkana	650	180	2.52	1.62	90	
Peterkin	200 " " "	F. M. Bordeaux	Monticello	860	287	9.63	1.30	8.63	
Moon	200 " " "	W. P. Hale	Lufra	480	160	63	1.30		67
Peterkin	100 " " "	A. G. Jarman	Barton	850	310	12.15	65	11.50	
Peterkin	200 Cotton Seed Meal 200 Acid Phosphate	F. M. Bordeaux	Monticello	800	266	7.74	2.60	5.14	
Moon	200 Cotton Seed Meal 200 Acid Phosphate	W. P. Hale	Lufra	800	266	10.17	2.60	7.57	
Peterkin	100 Cotton Seed Meal 100 Acid Phosphate	A. G. Jarman	Barton	950	350	15.75	1.30	14.45	
Peterkin	200 Cotton Seed Meal 200 Acid Phosphate 50 Chloride of Potash	F. M. Bordeaux	Monticello	980	327	13.23	3.95	9.28	
Moon	Same as above	W. P. Hale	Lufra	800	266	10.17	3.95	6.22	
Peterkin	100 Cotton Seed Meal 100 Acid Phosphate 85 Chloride of Potash	A. G. Jarman	Barton	1170	450	24.75	1.95	22.80	

VARIETY.	POUNDS OF FERTILIZER PER ACRE.	EXPERIMENTER.	LOCATION.	YIELD POUNDS SEED COTTON PER ACRE.	YIELD POUNDS LINT PER ACRE.	VALUE OF INCREASE AT 9c. PER POUND.	COST OF FERTILIZER.	PROFIT PER ACRE.	LOSS PER ACRE.
Peterkin	200 Acid Phosphate 50 Chloride of Potash	F. M. Bordeaux	Monticello	920	307	$11.43	$2.65	$8.78	
Moon	Same as above	W. P. Hale	Lufra	720	240	7.83	2.65	5.18	
Allen	100 Acid Phosphate 25 Chloride of Potash	A. G. Jarman	Barton	900	250	6.75	1.35	5.40	
Peterkin	200 Cotton Seed Meal 50 Chloride of Potash	F. M. Bordeaux.	Monticello	1000	333	13.77	2.43	11.34	
Moon	Same as above	W. P. Hale	Lufra	600	200	4.23	2.43	1.80	
Peterkin	100 Cotton Seed Meal 25 Chloride of Potash	A. G. Jarman	Barton	830	260	7.65	1.22	6.43	
Peterkin	300 Cotton Seed Meal 300 Superphosphate	A. F. Cory	Pine Bluff	770	257	7.29	4.95	2.34	
Moon	250 Cotton Seed Meal 250 Superphosphate	J. K. Fitzgerald	Texarkana	740	230	7.02	4.45	2.57	
Peterkin	350 Superphosphate	A. F. Cory	Pine Bluff	440	147	1.98	3.50		$1.52
Peterkin	300 Cotton Seed Meal 300 Superphosphate 80 Chloride of Potash	A. F. Cory	Pine Bluff	800	266	8.10	6.75	1.35	
Moon	250 Cotton Seed meal 250 Superphosphate 60 Chloride of Potash	J. K. Fitzgerald.	Texarkana	810	250	8.82	7.10	1.72	

VARIETY.	POUNDS OF FERTILIZERS PER ACRE.	EXPERIMENTERS.	LOCATION.	YIELD POUNDS SEED COTTON PER ACRE.	YIELD POUNDS LINT PER ACRE.	VALUE OF INCREASE AT 9c PER POUND.	COST OF FERTILIZER.	PROFIT PER ACRE.	LOSS PER ACRE.
Moon	250 Superphosphate 60 Chloride of Potash	J. R. Fitzgerald	Texarkana	620	190	$3.33 Value of Pro. at 9c. per lbs.	$3.85		52
Peterkin	Nothing	A. F Cory	Pine Bluff	375	125	$11.15			
"	Nothing	"	Pine Bluff	530†	176	15.84			
Moon	Nothing	J. R. Fitzgerald	Texarkan	500	150	13.50			
"	Nothing	"	Texarkana	510	170	15.30			
Peterkin	Nothing	F. M. Bordeaux	Monticello	540	180	17.20			
Moon	Nothing	W. P. Hale	Lufra	440	146	13.14			
"	Nothing	"	Lufra	480	160	14.40			
Sundry	Nothing	A. G. Jarman	Barton	525*	175	15.75			

*The average yield of upland in Phillips County.
†Vide remarks on this yield in P. B. result.

The following table shows the average results obtained with chemicals and profits thereon.

FERTILIZER AVERAGE POUNDS PER ACRE.	AVERAGE YIELD SEED COTTON PER ACRE.	AVERAGE YIELD LINT PER ACRE.	COST OF FERTILIZERS.	PROFITS.	LOSS.
166.6 Cot. s'd meal 166.6 Acid phosp'te 41.6 Chlo'de potash	983.3	327.	$3.10		
166.6 Cot. s'd meal 166.6 Acid phos'ate	851	283.7	2.17		
166.6 Acid phos'ate 41.6 Chlo'de potash	846.6	282.2	2.02		
166.6 Cot. s'd meal 41.6 Chlo'de potash	810	270	2.02		
275 Cot. seed meal 275 Superphosphate 70 Chloride potash	805	268.3	5.50		
275 Cot. seed meal 275 Superphosphate	755	251.6	3.93		
210 Cotton seed meal	697	232.3	$1.36		
200 Acid phosphate	695	231.6	1.30		
83.3 Sodic nitrate	650	216.6	2.49		
71 Ammonic sulphate.	640	213.3	2.48		
53 Chloride potash	616	205.3	1.21		
230 Kainit	588	188.6	1.38		

These data are naturally calculated from the results obtained in different parts of the State, and must be taken tentatively as indicating the way in which fertilizing work should be done. In certain instances it will be noticed that occasionally an individual result is higher than the average and perchance, on that particular piece of land the fertilizer that gave the highest result might be the more desirable, but for those who wish to be safe, we most decidedly recommend the use of the mixture giving the highest average results. Next year we shall continue our work in this direction. We advise conditionally the following chemical formula for cotton per acre:

200 pounds cotton seed meal.
200 " acid phosphate.
50 " chloride of potash.

Our experiments with the composts have only as yet been made at two places, and we consequently do not care to base many conclusions thereon, they will be repeated. We are firm believers in composts, we would take as a choice from the results of our preliminary worth, the Georgia, Alabama com-

post and Furman's formula. The details of composts are given in the record of the Pine Bluff and Monticello experiments. The profits in lint values alone from their use are as follows, *at Monticello:*

COMPOST POUNDS PER ACRE.	YIELD SEED COTTON PER ACRE.	VALUE LINT AT 9C. PER POUND.	COST OF FERTILIZER.	PROFITS OVER UNFERTILIZED.
*5,550 Cow lot manure.... 300 Acid phosphate..... 150 Kainit	1468	$42.03	$5.35	$13.91
Same as above.....	1678	48.53	5.35	20.41
*3,600 Stable manure..... 90 Bus. Cotton seed..... .. 300 Acid phosphate ... . 150 Kainit	2128	63.83		
Nothing	760	22.79		

*Values of stable and cow lot manure are variable, we have put them at $1 per ton; farmers will have to calculate the local value.

We have not calculated the profit in the Pine Bluff composts for various reasons, mainly, owing to the fact, that the freight was delayed, and consequently prevented us from allowing the composts to stand the proper length of time.

Mr. Fitzgerald's Experiments at Texarkana.

These experiments were similar to those carried on at Pine Bluff. The cotton was planted from April 16th to April 25th on beds, the beds being harrowed down just before planting, making them comparatively level. The planting was done with a planter, the seed being covered shallow. By May 1st there was a good stand of cotton. The latter part of the first week in May we commenced scraping off very shallow with a turning plow, at the same time, the thinning commenced, the hoes went just behind the plow that was scraping and thinned as required. A week later a scraper was run around the cotton just behind the hoes. The third week in May the cotton was thinned to a stand. After this it was run around with a shovel plow. The first week in June, the middles of cotton were plowed out with a double-shovel; directly after this we hoed again, rains having made it necessary. The middle of June we plowed with a 14-inch shovel, it did very good work cleaning both cotton and the middles. The last of June a cultivator was run through the middles. The second week in July a large shovel was run around the cotton, directly after this the middles were split with a shovel. The first and beginning of second weeks in July the

cotton was hoed for the last time. All the cotton plats were planted and worked alike. The following table shows the results of experiments with fertilizers on one-tenth acre plots:

Experiments with Fertilizers.

FERTILIZERS USED. POUNDS PER ACRE.	COMMENCED TO BLOOM.	COMMENCED TO OPEN.	POUNDS SEED COTTON PER ACRE.	POUNDS LINT PER ACRE.	POUNDS SEED PER ACRE.
250 pounds of cotton seed meal	June 30	August 4	650	180	470
300 pounds kainit	June 28	August 8	640	220	420
80 pounds ammonium sulphate	July 1	August 7	740	250	490
250 pounds cotton seed meal.. 250 lbs. superphos	June 30	August 2	740	230	560
60 pounds chloride potash	July 1	August 7	710	240	470
250 lbs. su'phosphate 250 " cotton s'd m'l 60 " chloride potash	June 25	August 2	810	250	510
250 lbs. cotton s'd m'l 60 " muriate	July 2	August 4	400	120	280
250 lbs. su'phosphate 60 " muriate	June 29	August 8	620	190	430
300 " acid phosphate	June 27	August 6	850	270	580
Nothing.	July 2.	August 10.	490	140	350
Nothing.	July 2.	August 10.	500	150	350
Nothing.			510		

We made an experiment to determine the effects of deep and shallow cultivation of cotton, one-half acre being devoted to each test. They yielded:

1. Cotton plowed deep, 566 pounds to the acre of seed cotton.

2. Cotton plowed shallow, 538 pounds to the acre of seed cotton.

As this is a point of much interest and one that should not be decided by one year's experiment, we prefer to give our views on this result which is somewhat abnormal. We will first give Mr. J. K, Fitzgerald's opinion on the proper cultivation of cotton: "I do not think shallow plowing will do entirely for cotton, because between the months of May and July we almost invaribly have a wet spell for several days that the plow cannot run, during this time the grass is growing very fast and it cannot be covered up by shallow cultivation, if it is, the ends of the grass are left out, and the grass grows as vigorously as ever, or the small roots of the grass being very near the surface will put forth new shoots and grow. It is almost impossible to keep a cotton crop from getting grassy during a certain period

of the summer, and at this time if shallow plowing is adopted the crop will be ruined by the grass nine times out of ten. I do not know which would be the more injurious to the crop to plow deep so as to cover the grass and thereby kill it or plow shallow and let the grass grow and save the roots of the cotton; but I would prefer the deep plowing, as it does not seem to injure the growth of the cotton at all. The new crop of grass seed brought up can be killed before they get a good hold. The deep plowing instead of increasing the labor will diminish it by killing the grass which the shallow plowing will not do at this time. Deep plowing is necessary for cotton the first one or two workings whether there is a heavy rain fall or not. It is necessary to plow cotton shallower during the fruiting of the plant. To sum up: The first one or two workings the cotton should be plowed pretty deep, after that plow just deep enough to keep down grass, but just after the wet spell deep plowing will have to be resorted to to manage the grass, but plowing shallow in middles can be worked out at the time which will enable a man to work over his crop much sooner than when the cotton is plowed deep."

Examination of a cotton plant when about three and a half inches high showed it to have a root *three and a half feet long*, the end being only *three and a quarter inches* below the surface of the soil. Now it must be obvious that a system of cultivation which would destroy a very great part of the roots cannot be desirable, for the plant can only grow by means of the food which it gathers through its roots and hence after cutting them away until another set can be formed the growth must be retarded. The examination of the small plant was made according to the method of Dr. Newman, who has made several such examinations he found that "a plant two feet high just commencing to bloom had a root six feet long. Its extremity in its natural position was five feet one inch from the stalk. The position of the roots in the soil varied according to the point from which they left the tap root. Some of the longest left the tap root at one a half to two inches from the surface of the soil and gradually descended, reaching the clay sub-soil at from three to four feet from the plant. Several entered the clay three inches and continued at that depth. The tap root descended vertically to the depth of twelve inches, three inches into the sub-soil and then pursued a horizontal course at that depth. The usual deep cultivation with rooter would have destroyed four-fifths of the lateral roots which extended at right

angles to the row. The plant was cultivated entirely with the hoe up to the time of its removal. It was planted in garden soil, sandy drift filled with water-worn pebble soil nine inches deep, with tough yellow clay sub-soil." These observations coincide with our own, hence the apparent anomaly of the result obtained. There is no question but that deep cultivation is desirable nay almost a necessity after heavy spring rains, when the plants are up. Mr. Fitzgerald states that we were not bothered by any ground baking and ascribes his results to the reason stated in this discussion. Yield is everything, and this year his method of cultivation certainly has the advantage whether it was due to an abnormal season remains to be proved, we shall continue this line of inquiry in different sections of the State until we can get a satisfactory conclusion, until then we prefer to refrain from ennunciating any hard and fast rule.

Experiments with Varieties.—We made test of the following varieties and obtained the results as tabulated:

VARIETY.	PLANTED.	COMMENCED TO BLOOM.	COMMENCED TO OPEN.	LBS. SEED COTTON PER ACRE.	LBS. LINT PER ACRE.	LBS. SEED PER ACRE.
Hawkins	April 16..	June 29....	August 3..	444	144	300
Peerless	"	July 16.....	August 1..	558	192	366
Ozier Silk	"	June 30.....	August 3..	534	162	372
Jones	"	June 30.....	August 4..	582	186	396
Crawford	"	July 2.....	August 5..	594	192	402
Perterkin	"	July 8.....	August 14	552	216	336

The Peerless cotton seemed to mature a little before the other varieties. The Peterkin stood the drouth fairly, but did not do so well during the rainy weather, it is a slow grower until the warm weather sets in.

Mangold Wurzel.

This root is an enormous yielder, a fair food for stock. We tried it in various parts of the State, but except at Fayetteville the outlook was not favorable. We will however, give it another trial. The method of culture to be adopted is the following: Sow in April or early in May in thoroughly well prepared soil, in drills ten inches deep and about eighteen inches apart. Thin out to twelve inches, taking great care to keep the weeds down by hoeing and cultivating. About five pounds of seed to the acre is generally used. This crop has been

known under favorable conditions to yield as high as *seventy tons* to the acre. We are of the opinion that should ensilage succeed with us, we shall not have much use for roots. We made experiments with the following varieties, giving the undermentioned yields:

VARIETY.	YIELD POUNDS PER ACRE.
New Red Flesh Tankard	9,980
Improved Mammoth Long Red	16,300
Orange Globe	14,180
Red Globe	11,340
Golden Tankard	14,600
Knivers New Mangold	12,860
Norbiton Giant	18,740

Corn at Fayetteville.

We made test of a number of varieties of corn at this branch station with variable results, tabulated below:

VARIETY.	BUSHELS PER ACRE.
Illinois Premium Dent	60
Eden Prov. Dent	48
Crane Dent	46.6
Chadwick Yellow Flint	50.5
Silver White Flint	63.5
Reddish Flint	poor
Pride of the North	59.3
Top Over	56
White Star Dent	poor
Early Yellow	54
Chester County Mammoth	poor
Warsow Yellow	44
Mandan Indian	poor
Longfellow Flint	54
Old Cabin Home	40.8
Mammoth Chester Pa	poor
Tuscarora	37.5
Golden Dent	poor
Maryland White Gourd Seed	27.8
Hudson Bay	21
Va. Horse Tooth	24.6
Blounts' Prolific	poor
Golden Beauty	37.3
New Hickory King	36.6
White Giant Normandy	44

ENTOMOLOGIST'S REPORT.

INTRODUCTORY.

The past year, as far as I can find out, has not been marked by any widespread insect injuries. In a few limited localities the cotton worm has been more than usually destructive, but taking the State as a whole it has been rather below the average. In the immediate vicinity of Fayetteville the grapes seem to have suffered most by destructive insects, one of the worst of which is made the subject of the present report. The work of this department suffered a serious interruption by the death of my predecessor, Mr. S. H. Crossman, a young man of promising talents and an enthusiastic entomologist. In order that the work of the entomologist may be of the most practical benefit to the farmers of the State it is desired that we be notified whenever insects are becoming destructive. We will suggest such remedies as experience has shown to be the most effective, and if of sufficient importance, will go personally and study the insect on the ground. Whenever possible, specimens of the insects should accompany the inquiry so as to enable us to determine with certainty what the culprit is. Insects may be sent by mail at the rate of one cent an ounce. Pack them in a small wooden or tin box and never in pasteboard for they are sure to be crushed in the mail. No air holes need be made as they go better in a tight box. The publications of this department consist of bulletins and an annual report which are sent free on application. Inquiries will also be answered in the agricultural press of the State when of general interest. The present report contains an account of the life history of the grape leaf-folder to which is appended an article on the apple rust.

The Grape Leaf-Folder.

(*Desmia maculalis*, Westwood.)

This little insect has proven itself a veritable pest in some vineyards this season. It is not generally regarded in other parts of the country as a dangerous insect because of its not occurring in sufficient numbers to do much injury. Though quite widely distributed through the United States this seems to be the latitude best suited to it and the one in which it can most speedily under favorable conditions develop in destructive numbers. It is important for us here in Arkansas therefore to become acquainted with its life history and habits in order that we may the more intelligently combat it and prevent in a measure at least its injuries.

The insect has been known for over half a century, being first described by the great English Entomologist Westwood,* who placed it in a genus by itself on account of the peculiar structure of the *antennae* or feelers of the male.

The Egg.

The leaf-folder does not always remain a little worm but like other insects passes through a series of transformations, appearing successively in stages very dissimilar to each other. The first or egg stage has not been certainly observed as yet. It is a point of considerable importance in the life history of the insect and one which we intend to solve the coming season. Though nothing can be said about it from direct observation, still a knowledge of related species and observations on the young larvæ give us a clew to what will in all probability be found correct. The egg will most likely be found to be a simple spherical or oval body of a yellowish or greenish color and considerably smaller than the head of an ordinary pin. The young larvæ are found solitary in the spring almost invariably, and only when the insect becomes abundant is it the rule to find more than one young larva in a leaf, therefore we may conclude that the eggs are laid singly on the leaves. From the position of the young larvæ it is further probable that they are deposited early in the spring on the young and still folded leaves or in the buds, but later in the year they are generally placed inside of folded leaves already occupied by older larvæ. The moth being a night flyer she undoubtedly deposits them at night. The fruitless search made this year for the eggs may indicate that they hatch very shortly after being deposited.

*In Mag. de Zool., par M. Guerin, 1832; Pl. 2.

The Larva.

Fig. 1. Larva of the grape leaf-folder (*Desmia maculalis*) at the beginning of the second age. The line below indicates the natural size.

The second stage known as the larva is the one in which the insect spends most of its life and does the damage to the grape vine. Upon hatching from the egg the larva is a sixteenth of an inch long and of a pale yellowish green color without markings except on the head, where the eyes are marked by black spots. The body is composed of thirteen segments or rings including the head. The first three back of the head bear each a pair of rather slender jointed legs. The next two do not bear appendages; then follows four pair with long and very slender legs not divided into joints. After these are found two more segments without legs and finally a terminal segment bearing a fifth pair of jointless legs. The whole body is more or less wrinkled and sparsely clothed with long hairs. The head is large and the whole appearance is not very different from that shown in Fig. 1, which is a figure of the worm a little older, As has already been remarked these are generally found singly on the leaves. Even when first hatched the worm has the power to spin a very delicate silk, and it goes to work at once to make it a home by sewing the leaf together. It is thus protected from its enemies. As it grows its skin becomes too tight for it, so nature has provided a method by which it can relieve itself. This consists in literally crawling out of its skin. During the life of the caterpillar this is done four times. Figure 1 shows the insect after the first of these

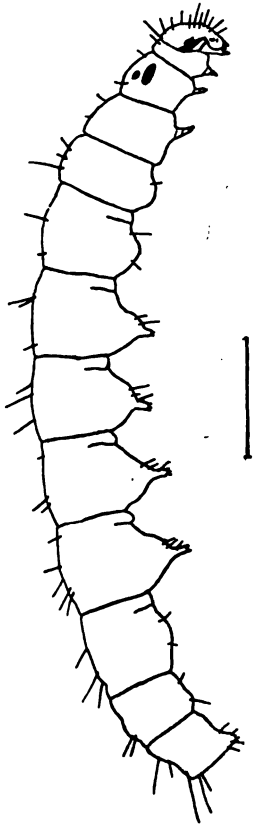


Fig. 2. Full grown larva of grape leaf-folder. (*Desmia maculalis.*

changes or moults. When it is about half grown, or perhaps sooner, the leaf on which it has been feeding is exhausted and it has to migrate to another. It generally selects a rather large leaf for its new home, folding it and fastening it down with silk as at first. If the insect is abundant it soon has company in the shape of small caterpillars of its own species. This is especially the case towards the latter part of summer. At the second moult there appears on the second segment back of the head four black spots, the two outermost being the larger. The sides of the head also are dark. After this time as the time of moulting approaches these head markings can be seen through the transparent skin of the first segment back of the head in which part the new forming head lies and looks like two curved brown spots on that segment.

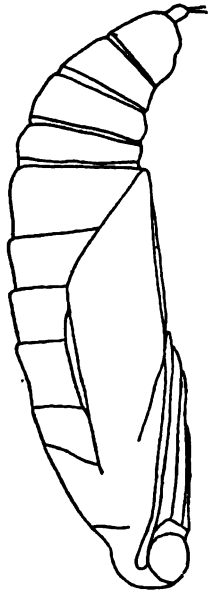


Fig. 3. Pupa of the grape leaf folder. (*Desmia maculalis.*)

The full grown larva is about 7/8 of an inch long, of a yellowish green color, and is shown in Figure 2. It is a very active little creature and if one is not careful when looking for him in a folded leaf he will wriggle himself out and escape by falling to the ground.

The Pupa.

After growing to its full size and devouring its full quota of grape leaves the larva becomes quiet and transforms into a brown spindle-shaped being called the pupa, in which it prepares for its future airy life as a moth. Before going through this transformation the larva prepares a neat little cell for itself all lined with silk of its own spinning. This is generally within a folded leaf, but sometimes it will take the trouble to cut out a piece from another leaf of a regular oval shape and sew it on in a very neat manner so as to form a cell beneath it. Within this cell the larva becomes yellow, shrinks in size, loses the use of its limbs and finally sheds its skin and becomes a pupa. If one examines the pupa he can see that many of the organs of the moth are already marked out. The duration of this stage varies according to the season. In the summer it may not be more than a week or ten days, but in the fall when the larva goes into the pupa state it is for all winter.

The Moth.

Fig. 4. The grape leaf-folder (*Desmia maculalis*) male much enlarged.

The moth or perfect insect, as it is called, comes forth from the pupa skin. In this stage the insect is a dainty little creature dressed in black and white. The male is shown in the cut (Fig. 4). The peculiar structure of the antennæ or feelers deserve attention, as this point makes it different from all related insects. The female has the usual slender thread-like antennæ of other moths. There is also another conspicuous difference between the male and female of this insect. The posterior wings of the female have two white spots instead of one as in the male. (See Fig. 5.) The moth is about a half an inch long and across the wings when spread, about seven-eighths of an inch. It is not as readily attracted by light as most moths and is not very often seen even when the species is destructive.

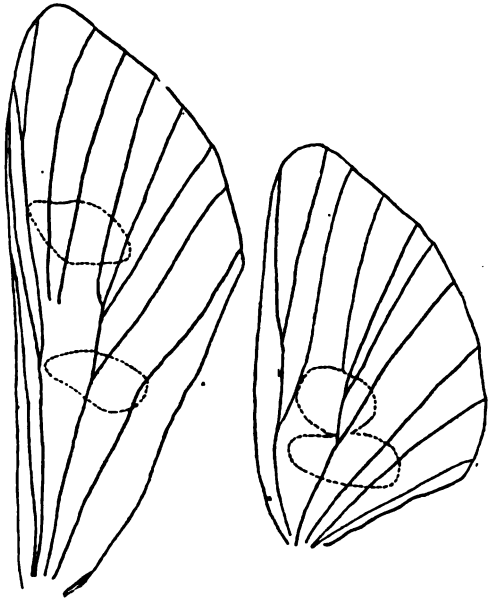


Fig. 5. Wing of the grape leaf-folder denuded of scales. Dotted lines shows the region of white scales in the female.

Natural Enemies.

Secure as the caterpillar appears in its folded leaf no less than six species of insects depend upon it wholly, or in part, for sustenance. One of these belonging to the same order as the bee was bred in considerable numbers. It feeds on the larva and when full grown spins a pretty little cocoon in which it transforms

into the perfect insect, I noticed also a very interesting example of what is known as secondary parasitism. Some of the cocoons instead of being broken open in the ordinary way had a little hole in the side and a number of very small insects belonging to the same order came out. These had evidently fed on the first.

The second was a fly belonging to a family having quite a number of parasitic species, the family *Tachinidæ*. The species is still undescribed, though Riley has given it the MS. name, *Tachina desmiæ*. This was not as abundant as the first mentioned insect but still will help considerable in keeping the leaf-folder in check. Two insects belonging to the true bugs were found feeding on the larvæ of the grape leaf-folder, but they were so few in numbers as to do but little good. Two species of small spiders are found at all times on grape vines and are of great service in keeping leaf-folder in check. They take possession of leaves which the larvæ had folded, destroying the inhabitant and feeding on other insects that seek in the folded leaf a place of concealment. Judging from some scales it seems probable that it captures the moth while on her duty of egg-laying. One of the species is the common white one so abunddant on flowers in the fall and it is not capable of folding its own leaf, but the other species does so readily. Prof. Riley mentions a clay-yellow beetle *(Colaspis Havida*, Say) of small size as a probable enemy of the leaf-folder. It was abundant this year, but I could find no evidence of its eating the larvæ.

Remedies.

Being hid as they are in the folded leaves it is very hard to reach them with poisons so that we were not very sanguine of the success of topical applications, but to test the matter we tried the effect of Paris green. Sprayed on in the ordinary way as strong as is safe for the leaves there was no appreciable effect. Such an application of the poison as this may act as a preventive, but certainly not as a cure. The worms can be killed in this way, but it requires more poison than it does to destroy the leaves. We sprayed vines with solutions of varying strength and by different methods. The method that seems best to overcome the diffiulty of reaching the larva within the folded leaf is long continued application of a gentle spray from above.

The only remedy seems to be hand-picking, and a word must be said as to time and method. Some recommend merely crushing the larva in the leaf. This should not be done unless

the leaf is also removed or straightened out, for it leaves a standing invitation to the moth to come and deposit more eggs. Besides, if not possessing a superhuman memory, one will have the useless task of squeezing the same leaf over and over again. If one will pick and destroy every folded leaf as soon as discovered he will keep his vineyard clean at the minimum of trouble and losses. If the vines have become badly affected before any attention is given to them it is probably the best plan to go to work and gather every folded leaf. It does not take as much time as one would think. I say gather the leaves for by so doing one can destroy his enemies without making his friends suffer. The gathered leaves may be placed in a box and covered with a fine gauze which will permit the parasites to escape but which will retain the moths. The fallen leaves may be gathered in the fall and the pupæ destroyed. The larvæ may not all pupate in the grape leaves and so we should emphasize clean culture. The insect seems to prefer grapes of the Labrusca class but sometimes becomes just as destructive on others. No good, therefore, need be expected from planting kinds not affected. Hand-picking is quite a satisfactory remedy, as I saw a large vineyard kept entirely clean by this method and the work was done by the men as they were cultivating and tending the vines without much or any loss of time.

BOTANICAL.

The Apple Leaf Rust.

A disease of the apple leaves commonly known as apple rust or apple leaf rust, was quite common in some places the past season and has awakened considerable interest, if not apprehension. It was quite generally attributed to insects but is the work of a very lowly organized plant—a fungus known to Botanists by the long name *Gymnosporangium*. Some trees had nearly every leaf spotted with the fungus and a considerable portion of the fruit was affected. The affected leaves and fruit generally turn yellow and fall, so that when the disease is bad it is certainly of great importance. The fungus that causes the disease presents the very interesting phenomenon of possessing two stages of development entirely different in appearance and growing upon two different and unrelated plants, but nevertheless invariably alternating with one another.

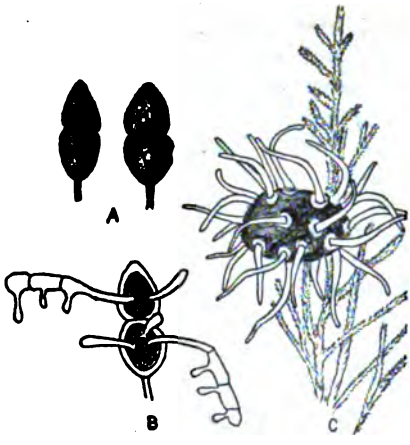


Fig. 6. *Gymnosporangium macropus Lk.*, on red cedar. A, spores; B, the same germinating; C, cedar apple showing radiating appendages. (After Farlow.)

It has been conclusively proven that the conspicuous jelly-like masses which are found in the spring on the red cedar and commonly known as cedar apples are but an alternating stage of the apple leaf rust, The life history of the fungus is about as follows: The spores from the cedar apples (Fig. 6, A. B.) germinate some time in the latter part of April or in May. This consists in one or more rod-like processes growing out of each of the cells of the two-celled spore. These processes divide into three or four parts, by means of partitions and each of these parts gives rise to an oval spore-like body by budding, called sporidium, being a simple cell with a comparatively thin cell wall. The sporidia thus formed are carried by the winds and probably also by birds and insects to the apple leaves where the fungus grows into the leaf, living on the sap and so irritating it as to cause a conspicuous swelling on the underside.

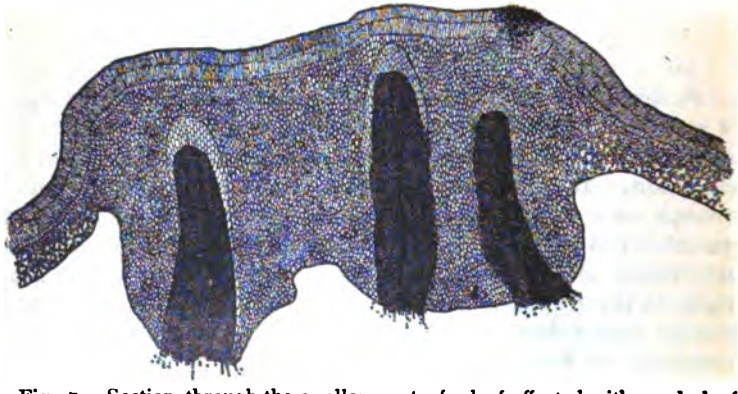


Fig. 7. Section through the swollen part of a leaf affected with apple leaf rust showing three of the spore cups very much magnified.

The fungus does not grow very large, depending as it does upon its host for sustenance, it need not develop extensive

organs for the collection and elaboration of food material, but can put all its powers to the formation of its reproductive organs. Little thread-like filaments grow from these sporidia and enter the leaf. They are called the mycelia or hyphae. Soon there appears at this spot a slight discoloration and in a few days a bright orange spot, These are on the upper side of the leaf and in a week or two there appears in the center black spots called spermagonia. They are, little cups filled with very minute spore-like bodies called spermatia. What the function of these bodies may be is still only a matter of speculation, though it seems quite likely that they are a third form of spore. They do not germinate readily, at least under ordinary circumstances. The question is one that may be solved by a lucky chance observation but more probably will require a long series of carefully conducted experiments and it may be of as great practical importance as it is of theoretical and scientific value,

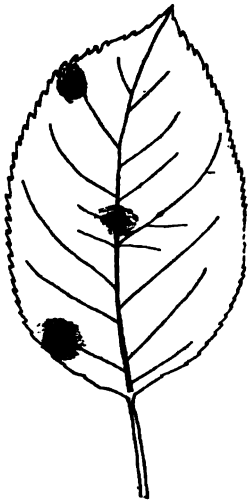


Fig. 8. Apple leaf affected with the rust. Seen from beneath.

Somewhat later, about June or July, there arises from the same spot on the under side of the leaf a much larger and deeper form of cup filled with rows of spores. These find their way back to the cedar trees upon which they germinate at once, producing a swelling often more than an inch in diameter. This is the cedar apple, a brown more or less spherical body covered with shallow pits. In this form it passes the winter, in the spring in the place of the pits we see protrusions of a lighter color, and when ripe these swell out after a rain into long sprangling arms of a bright yellow color and jelly-like structure. The whole mass swells at the same time but not to the extent that the arms do. Imbedded in these arms one may find by means of the microscope numerous two-celled spores with long slender stalks. These spores germinate at once as described above and are ready to begin their life again upon the apple.

Remedies.

One will see that this being the life history of the fungus we have at our command a remedy that will be certain in its action. If we destroy the fungus in one of its stages we have

destroyed it in the other. The stage where it does the most injury, that is on the apple, is one in which it would be almost impossible to destroy, but the case is different with the cedar. Red cedar is not a very valuable tree and so could be cut down where not wanted for ornament and the cedar apples carefully picked from the ornamental trees during the winter. If the fruit grower will see to it that all red cedar trees are either destroyed or the cedar apples picked and destroyed within a few miles of his orchard he will not be troubled by apple leaf rust.

ANALYSES OF FODDER.

This work is one of extreme importance and value to the stockmen of the State, as on the percentage of certain ingredients in the food depends its value for stock. Most food stuffs have been analyzed by German chemists, but German values will not do for Arkansas. We are bound to have all the fodders raised in the State examined since it is found that their composition is not constant in all places. The nutritive value of a food depends upon the amounts of albuminoids and carbohydrates that are digestable.

Albuminoids are substances composed of carbon, hydrogen, oxygen and nitrogen, they take the same place in the vegetable world that flesh does in the animal, and it is generally admitted that they are the source of muscular fibre, or as they are commonly called "flesh formers."

Carbohydrates are substances composed of carbon, hydrogen and oxygen, they take the same place in the vegetable world that fat does in the animal, and are commonly called "fat formers."

In the analyses under mentioned carbohydrates will be found as "fat" "crude fibre" and "nitrogen free extract," consequently, to get the total percentage we must add the percentages of these three substances, the per cent. of fat being multiplied two and one-half times. In a former place in this article mention was made of percentages of "substances digestible." It is obvious that the food digested is the part that nourishes and supports the animal, consequently to obtain the actual value of a food these digestion determinations have to be made in addition to the ordinary analyses. We have commenced work in this direction and so far have made the following determinations:

Japan Clover (Lespediza Striata) Hay.

This plant which is rapidly coming to the front all through the South as a desirable fodder, has the following composition:

Water	12.82
Albuminoids	13.84
Crude Fibre	26.45
Fat	3.44
Nitrogen Free Extract	30.63
Ash	12.82
Total	100.00

The percentage of digestible albuminoids has not yet been determined.

Tall Oat Grass Hay.

Water	10.68
Albuminoids	8.69
Crude Fibre	27.85
Fat	3.30
Nitrogen Free Extract	44.48
Ash	5.00
Total	100.00

Albuminoids digestible 70 per cent.

Orchard Grass (Dactylis Glomorata) Hay.

Water	10.47
Albuminoids	10.40
Crude Fibre	28.94
Fat	2.50
Nitrogen Free Extract	42.46
Ash	5.23
Total	100.00

Albuminoids digestible 67 per cent.

Alsike Clover (Trifolium Hybridum) Hay.

Water	11.46
Albuminoids	9.16
Crude Fibre	25.05
Fat	2.30
Nitrogen Free Extract	45.93
Ash	6.10
Total	100.00

Albuminoids digestible 69 per cent.

Medium Red Clover (Trifolium Pratense) Hay.

Water	14.00
Albuminoids	13.52
Crude Fibre	27.50
Fat	5.27
Nitrogen Free Extract	34.51
Ash	5.20
Total	100.00

Albuminoids digestible 65 per cent.

Red Top (Agrostis Vulgaris) Hay.

Water	10.00
Albuminoids	10.43
Crude Fibre	24.00
Fat	2.31
Nitrogen Free Extract	46.76
Ash	6.50
Total	100.00

Albuminoids digestible not determined.

Wheat Straw.

Water	14.10
Albuminoids	3.22
Crude Fibre	42.50
Fat	1.38
Nitrogen Free Extract	34.48
Ash	4.30
Total	100.00

Albuminoids digestible 28 per cent.

Mixed Hay.

Water	13.89
Albuminoids	9.84
Crude Fibre	27.40
Fat	2.49
Nitrogen Free Extract	41.86
Ash	5.52
Total	100.00

Albuminoids digestible 41 per cent.

Timothy (Phleum pratense) Hay.

Water	15.10
Albuminoids	7.95
Crude Fibre	26.50
Fat	2.00
Nitrogen Free Extract	44.13
Ash	4.32
Total	100.00

Albuminoids digestible 50 per cent.

Bran.

Water	13.17
Albuminoids	14.65
Crude Fibre	8.20
Fat	3.80
Nitrogen Free Extract	52.97
Ash	7.21
Total	100.00

Albuminoids digestible 80 per cent.

Cotton Seed Meal.

Water	9.55
Albuminoids	44.22
Crude Fibre	6.50
Fat	8.76
Nitrogen Free Extract	23.77
Ash	7.20
Total	100.00

Albuminoids digestible 85 per cent.

Corn Meal.

Water	12.07
Albuminoids	8.42
Crude Fibre	2.05
Fat	4.47
Nitrogen Free Extract	71.74
Ash	1.25
Total	100.00

Albuminoids digestible 74 per cent.

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Second Annual Report

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Arkansas Agricultural Experiment Station

—AT—

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HON. J. P. EAGLE, *Governor of the State of Arkansas.*

Sir:

I have the honor to herewith transmit the Second Annual Report of the Arkansas Agricultural Experiment Station.

I am, Sir,

Most respectfully, your obedient servant,

ALBERT E. MENKE,
Director.

ARKANSAS INDUSTRIAL UNIVERSITY.

AGRICULTURAL EXPERIMENT STATION.

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C. B. COLLINGWOOD ..... Chemist.
G. A. HUMPHREYS ..... Assistant Chemist.
F. CORY ..... Assistant at Pine Bluff.
R. L. BARNETT ..... Assistant at Newport.
W. F. BATES ..... Assistant at Fayetteville.

An Act accepting the provisions of the Act of Congress establishing Agricultural Experiment Stations.

Be it enacted by the General Assembly of the State of Arkansas:

SECTION 1. That the State of Arkansas hereby accepts the appropriation made to her, in common with other States, by the Act of Congress, entitled "An Act to establish Agricultural Experiment Stations in connection with the colleges established in the several States, under the provisions of an Act approved July 2, 1862, and of the acts supplementary thereto, approved March 2, 1887;" and said appropriation is accepted and assented to in trust for the uses and purposes expressed in said Act of Congress, and all moneys received by the State under said Act of Congress, shall be, and the same are, hereby assigned and appropriated for use and disbursement to the Arkansas Industrial University, a college established at Fayetteville in this State, under the provisions of the Act of Congress approved July 2, 1862.

SEC. 2. *Be it further enacted*. That this Act shall be in force from and after its passage.

Approved, March 7, 1889.

CHEMICAL DEPARTMENT.

C. B. COLLINGWOOD, Chemist.
G. A. HUMPHREYS, Assistant Chemist.

During the past year, 459 quantitative analyses have been completed. The list includes water, cotton seed hulls, shells, ensilage, strawberries, land plaster, butter, wine, oats, fertilizers, milk and sorghum.

SHELLS FROM OUACHITA COUNTY.

SENT BY HON. W. F. AVERA.

Calcium Carbonate $Ca\ Co^3$	91.19
Phosphoric Acid, $P^2\ O^5$	.30
Insoluble matter	8.51
	100.00

No trace of nitrogen, potash or sulphur. The shells were sent to have their agricultural value determined. The amount of phosphoric acid is too small to be valuable; but the lime would be beneficial on soils rich in humus.

SMUT DESTROYER.

FROM WASHINGTON, D. C.

Lead as Acetate	88.93
Lead as $Pb\ O^2$	1.13
Organic matter and water	9.94
	100.00

ENSILAGE.

CUT CORN FROM COLLEGE BARN.

In good condition.

Moisture	74.31
Dry matter	25.69

ANALYSIS OF DRY MATTER.

Crude Protein	2.05
Crude Fibre	35.26
Crude Ash	2.13
Ether extract	1.16
Non-nitrogenous extract	59.40

WHOLE CORN FROM PINE BLUFF.

In poor condition.

Moisture	52.52
Dry matter	47.48

ANALYSIS OF DRY MATTER.

Crude Protein	2.98
Crude Fibre	26.59
Crude Ash	3.05
Ether extract	1.12
Non-nitrogenous extract	66.26

PEA VINES FROM PINE BLUFF.

In poor condition.

Moisture	47.78
Dry matter	52.22

ANALYSIS OF DRY MATTER.

Crude Protein	6.81
Crude Fibre	27.76
Crude Ash	9.39
Ether extract	2.34
Non-nitrogenous extract	53.70

ANALYSIS OF WINES.

FROM DENGLER, HOT SPRINGS, ARK.

NAMES.	SP. GRAVITY.	ALCOHOL BY WEIGHT.	ALCOHOL BY VOLUME.	TOTAL RESIDUE AT 100C	TOTAL ASH.	GLUCOSE.	TOTAL ACID.	GLYCERINE.
Hock	1.0010	5.62	7.01	2.24	0.28	0.40	.729	.483
Claret	.9962	8.07	10.03	2.46	0.27	0.36	.543	.523

FERTILIZERS.

C. B. COLLINGWOOD.

The following article has been written because a few fundamental facts in regard to the influence of plant food on plant growth seem desirable at the beginning of a report which has so many experiments with fertilizers.

A plant derives a part of the elements which enter into its growth from the air, and a part from the soluble material in the soil. If the portion taken from the soil by the plant is not returned for a series of years, the land becomes worn out and incapable of producing a full and paying crop. The question naturally arises, what element or elements has the soil lost in thus parting with its fertility?

Plants show by analysis, that they are made up of carbon, nitrogen, sulphur, potassium, sodium, iron, hydrogen, oxygen, phosphorus, calcium, manganese and silicon. As these elements are always present, it is fair to conclude that they are necessary to plant growth. Other elements are sometimes present in variable quantities, but are not considered absolutely essential.

A barren soil, then, is one in which one or more of these elements is absent, or, if present, is only to be found in an insoluble condition. All but a few of these elements are so generally present, or are removed from the soil in such small quantities that it is seldom necessary to supply them artificially. Nitrogen, phosphorus, potassium, and, perhaps, calcium, are the most important of those which must be supplied. Calcium (lime), is always beneficial to a soil, and its effect on other elements is very important by rendering them more soluble. It is cheap, and its effects on a soil can be readily determined by direct experiment.

A worn out soil is always deficient in either nitrogen, phosphorus, or potassium, or perhaps, in all three. The following table will show the number of pounds of these valuable elements taken from an acre of soil by cotton, wheat and corn:

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Cotton, 1000 lbs. of seed to the acre	32.7	8.4.	10.5
Wheat, 30 bushels to the acre	45.0	22.7.	27.9
Corn, 50 bushels to the acre	56.0	58.0	25.1

It is only a question of time for the most fertile soil to become impoverished unless some means are taken to return to the soil that which is taken away by plant growth. Barnyard manure, if properly utilized, contains all the elements of fertility. It belongs to the soil and should be returned to it. Often there is not sufficient of this, and fertilizing material must be obtained from an outside source.

SOURCES AND COST OF NITROGEN.

Nitrogen is found in large quantities in the nitre beds of Chili and Peru, and in the deposits of Guano on the almost rainless islands along the West coast of South America. The quantity brought to this country every year is enormous. Of the farm crops, the seeds are the most nitrogenous parts. When the wheat is sold from the farm, a large amount of valuable nitrogen is lost to the farmer. When cotton is sold the valuable elements of fertility are left behind in the seed.

Nitrogen, from the nitrates, bones or dried blood, is considered to be worth about 17 cents per pound at the centers from which it is shipped. In cotton seed meal we have a form of nitrogen which can be purchased for much less. An analysis of cotton seed meal shows:

Nitrogen	6.40 per cent.
Phosphoric Acid	1.53 per cent.
Potassium Oxide	0.81 per cent.

If we represent the nitrogen to be twice as valuable as the phosphoric acid, and three times as valuable as the potassium oxide, when a ton can be purchased for $14.00, it will give the

following values: Nitrogen 10 cents per pound; phosphoric acid, 5 cents per pound; potassium oxide 3 1/3 cents per pound. Cotton seed meal, then, is the cheapest form of nitrogen for the farmer of this State. Their attention is respectfully directed to experiments recorded in this report, in which the fertilizing effects of cotton seed meal are compared with more costly forms of nitrogenous fertilizers. If the meal was fed to animals, and all the manure saved, it would contain 90 per cent. of the fertilizing material. All the manure means both liquid and solid.

SOURCES AND COST OF PHOSPHORIC ACID.

Phosphoric acid is obtained from the bones of animals and from the phosphatic rocks of South Carolina and Canada. The former supply is limited, and must be supplemented by the latter. Since the discovery of the phosphatic rocks of South Carolina, thousands of tons have been used for fertilizing material. The value of phosphates depends, to a certain extent, on the fineness with which they are ground. When treated with strong sulphuric acid, the phosphates become partly soluble, but after a time, a part of this soluble phosphoric acid goes back or reverts to an insoluble form and is known as citrate soluble, or reverted phosphoric acid. It is considered of about the same value as the soluble variety.

The common phosphatic fertilizers offered for sale in this State are given below:

Ground Bone. The value depending somewhat on the fineness with which it is ground. All bones not burned contain nitrogen, but no appreciable amount of potassium.

Dissolved Bone is formed by acting on bones with strong sulphuric acid.

Floats consist of phosphatic rock ground to an exceedingly fine powder.

Acid Phosphate is formed by treating the phosphatic rock with strong sulphuric acid. Phosphorus always occurs in

combination with calcium, so that a supply of the former always furnishes sufficient lime.

The prices commonly quoted in shipping centers are as follows:

Soluble or reverted phosphoric acid..... 8 cents per pound.
Insoluble phosphoric acid from bones ..... 7 cents per pound.
Insoluble phosphoric acid from phosphatic rocks 2 cents per pound.

SOURCES OF POTASH.

Potash is found in the ashes of all land plants. Cotton seed hull ash contains from 5 to 40 per cent., and wood ash from 1 to 6 per cent. of potassium oxide. Both are cheap and valuable sources of potash.

Kainit is found in some of the German salt mines. It contains from 10 to 24 per cent. of potassium oxide, valued at 5 cents per pound.

A few words in regard to the distinction between cost and agricultural value of fertilizers may not be out of place here. The cost is determined by the market price of fertilizing materials, plus cost of mixing, manufacturers' profit and freight to a given point. Agricultural value is determined by ability to produce a larger crop than could otherwise be grown on the same soil and under the same conditions of climate, cultivation, etc. The agricultural value can be determined only by actual field test, because the needs of the soil, kind of crop, mode of cultivation and many other facts affect the growth of the plant.

The experiments with fertilizers recorded in this report have been made on measured plots, with weighed quantities of fertilizing material, and are of interest because they compare the effect of the various fertilizers on the same and different crops.

Every farmer should carefully test his own soil. This can be done by measuring an acre, dividing it into ten equal parts and using different kinds of fertilizers on these plots. At least two of these plots should be left unfertilized to note the condition of the soil. It would be well to leave a space five feet

wide between the plots. They might be fertilized as follows: Plot No. 1, barnyard manure; No. 2, nothing; No. 3, nitrogen; No. 4, potash; No. 5, phosphoric acid; No. 6, nitrogen and potash; No. 7, nitrogen and phosphoric acid; No. 8, nothing; No. 9, phosphoric acid and potash; No. 10, nitrogen, phosphoric acid and potash. With care in weighing fertilizers and measuring crops, the fertilizer which will give best returns for the money can readily be determined.

The last legislature passed a law requiring the analysis of all fertilizers offered for sale in the State at more than $10.00 per ton. This analysis must be attached to each package sold. Any farmer in the State can have an analysis made, free of cost, if he follow instructions for sampling and forward sample to the Experiment Station.

Instructions for Sampling Commercial Fertilizers for the Arkansas Agricultural Experiment Station.

Chemical analysis of a small sample, so taken as to fairly represent a large lot, will show the composition of the fertilizer. The accompanying instructions, if faithfully followed, will insure a fair sample. Special care should be observed that the sample neither gains nor loses *moisture* during sampling or sending, as may easily happen in extremes of weather, or from even a short exposure to sun and wind, or from keeping it in a poorly closed vessel.

FIRST—Provide a cup, some large papers, and for each sample a glass fruit can or tin box, holding about one quart, that can be tightly closed, all to be clean and dry.

SECOND—Weigh separately at least three (3), average packages (barrels or bags) of the fertilizer, and enter these actual weights in the "Form for Description of Sample."

THIRD—Open the packages that have been weighed and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor if needful, and crushing any soft, moist lumps, in order to aid mixture, but leaving

unbroken, hard dry lumps, so that the sample shall exhibit the texture and mechanical condition of the fertilizer.

FOURTH—Take out five (5) equal cupfuls from different parts of the mixed portions of each package, pour them (15 in all), one over another upon a paper, intermix thoroughly but quickly to avoid loss or gain of moisture, close tightly, *label plainly*, and send, charges paid, to the

ARKANSAS AGRICULTURAL EXPERIMENTAL STATION,
Fayetteville, Ark.

Form of Description of Sample for Analysis at the Laboratory of the Arkansas Agricultural Experiment Station.

The person sending samples to the station for gratuitous analysis, will be provided with a form like the following for each sample, and must fill up every one of the blank particulars given, so as to make the description complete and definite. The writing should be plain and legible:

If any printed circular, pamphlet, analysis or statement accompanies the fertilizer, or is used in its sale, send copy with the specimen.

1. Brand fertilizer.....
2. Name and address of manufacturer,

.....

3. Name and address of dealer from whose stock this sample is taken,

.....

4. Date of taking this sample,

.....

5. Selling price per ton, bag or barrel,

.....

6. Selling weight claimed for each package weighed,

.....

7. Actual weights of packages opened,

.....

8. Copy of analysis or guaranteed composition affixed to packages of this fertilizer,

.....

9. Signature and P. O. address of person taking and sending this sample.

AN ACT TO REGULATE THE SALE OF FERTILIZERS IN THIS STATE AND TO PROTECT THE AGRICULTURIST IN THE PURCHASE OF SAME.

Be it Enacted by the General Assembly of the State of Arkansas.

SECTION 1. On or before the first day of January of each year, before any person or company shall sell, offer or expose for sale in this State any commercial fertilizer, whose retail price is more than $10.00 per ton, said person or company shall furnish to the Superintendent of Agriculture, at the State University, a quantity of such fertilizer, not less than one pound, sufficient for analysis, accompanied by an affidavit that the substance so furnished is a fair and true sample of a commercial fertilizer which the said person or company desires to sell within the State of Arkansas, giving the name of brand of fertilizer and the place and name of the manufacturer.

SEC. 2. It shall be the duty of the Superintendent of Agriculture at the said Experiment Station to make, or cause to be made, a chemical analysis of every sample of commercial fertilizer so furnished him, and shall issue a certificate to the person or company so furnishing said sample, setting forth the said analysis as a true and complete analysis of the sample furnished him of such brand of fertilizer, giving the per cent. of ammonia, potash and available phosphoric acid in such sample of commercial fertilizer so furnished and all other available fertilizing ingredients in said sample.

SEC. 3. Every package of commercial fertilizer offered for sale within the State, whose value is more than ten dollars per ton, must have placed upon or securely attached to each package by the manufacturer a guaranteed analysis, which shall substantially correspond with the analysis of the sample of same brand so furnished the Superintendent of Agriculture, as directed in Section 1 of this act; also the brand of fertilizer and the name of the manufacturer.

SEC. 4. Any manufacturer or vendor of any commercial fertilizer, who shall sell, offer or expose for sale, any fertilizer, without having previously complied with the provisions of the act, hereinbefore set forth, shall be guilty of a misdemeanor, and upon conviction thereof be fined one hundred dollars for each violation or evasion of this act, which fines, less the Prosecuting Attorney's fees and other assistants, shall accrue to the benefit of and be paid into the State Treasury.

SEC. 5. The Superintendent of Agriculture of the State University shall receive for analyzing a fertilizer and affixing his certificate thereto, the sum of fifteen dollars for each and every brand of fertilizer analyzed for any manufacturer or vendor. But any agriculturist in the State, a purchaser of any commercial fertilizer, in this State, may take a sample of the same under the rules and direction of the said Superintendent of Agriculture at the said Experiment Station and forward same to said Superintendent of Agriculture for analysis, which analysis shall be made free of charge. Should any fertilizers be found to differ materially from the constituents as stamped on the package or packages of said fertilizer, the manufacturer and vendor shall be liable to indictment, as hereinbefore provided.

SEC. 6. This act shall be in force from and after its passage, and all laws in conflict with this act shall be repealed.

Approved March 8th, 1889.

	NAME OF BRAND.	NAME OF DEALER OR MANUFACTURER.	SAMPLED BY
1	Kainit	Stern's Fertilizer Co., New Orleans, La	Manufacturer.
2	Acid Phosphate	Stern's Fertilizer Co., New Orleans, La	Manufacturer.
3	Stern' sAmmoniated Raw Bone Superphosphate	Stern's Fertilizer Co., New Orleans, La	Manufacturer.
4	Memphis Fertilizer	Memphis Fertilizer Co., Memphis, Tenn	Manufacturer.
5	Pure Bone Meal	Geo. F. Bruner & Co., St. Louis, Mo.	Station Chemist.
6	Planter's Cotton	Planter's Fertilizer Manufacturing Co., New Orleans	Manufacturer.
7	Rock City Guano	National Fertilizer Co., Nashville, Tenn.	Manufacturer.
8	Tenn. Guano	National Fertilizer Co., Nashville, Tenn	Manufacturer.
9	Pure Bone Meal	Geo. F. Bruner & Co., St. Louis, Mo	
10	Bruner's Crop Multiplier	Geo. Bruner & Co., St. Louis, Mo	
11	Kainit	E. Craig, Jr., & Co., Little Rock, Ark	
12	Acid Phosphaie	E. Craig, Jr., & Co., Little Rock, Ark	
13	Memphis Fertilizer	E. Craig, Jr., & Co., Little Rock, Ark	
14	Cotton Seed Hulls	From Pine Bluff	
15	Cotton Seed Meal	From College Barn	Station Chemist.
16	Unleached Wood Ashes		Station Chemist.
17	Leached Wood Ashes		Station Chemist.

	NAME OF BRAND.	NAME OF DEALER AND MANUFACTURER.	SAMPLED BY.
18	Complete Fertilizer	A. B. Meyer & Co., St. Louis, Mo	Manufacturer.
19	Stern's Ammoniated Raw Bone Super Phosphate.	Standard Guano & Chemical Mf'r'. Co, New Orleans, La.	Manufacturer.
20	Kainit	Standard Guano & Chemical Mf'r'. Co., New Orleans, La.	Manufacturer.
21	Champion Farmers Choice	Standard Guano & Chemical Mf'r'. Co., New Orleans, La.	Manufacturer.
22	Acid Phosphate	Standard Guano & Chemical Mf'r'. Co., New Orleans, La.	Manufacturer.
23	Increscent Brand Bone Meal.	P. B. Mathiason, St. Louis, Mo	Manufacturer.
24	Dissolved Bone	P. B. Mathiason, St. Louis, Mo	Manufacturer.
25	St. Louis Fertilizer	P. B. Mathiason, St. Louis, Mo	Manufacturer.
26	Memphis Fertilizer	Memphis Fertilizer Co., Memphis, Tenn	

Ex—2

	PHOSPHORIC ACID.										NITROGEN. N.		POTASH. K_2O.		MOISTURE.		VALUE PER TON.	
	Soluble.		Reverted.		Insoluble.		Available.		Total.									
	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Claimed.	Found.	Price	Value
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.57	.....	4.18	.....	16.57
2	.....	18.73	.....	2.30	.....	0.87	.....	21.03	.....	21.91	.....	.....	.....	.....	.....	10.76	.....	33.96
3	.....	11.67	.....	2.07	.....	0.84	.....	13.74	.....	14.58	.....	1.54	.....	2.36	.....	17.30	.....	30.38
4	.....	4.28	.....	2.81	.....	1.81	.....	7.09	.....	8.90	.....	2.42	.....	2.88	.....	12.86	.....	21.50
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.05	.....	3.90	.....	.....	.....	9.77	.....	44.11
6	9	7.18	1	0.76	.....	0.26	10	7.94	.....	8.20	3	2.52	.....	2.51	.....	16.10	.....	22.49
7	6 to 7	5.80	2 to 3	3.78	1 to 3	2.60	8 to 9	9.58	.....	12.18	2 to 3	2.84	.....	2.84	.....	10.28	.....	29.34
8	6 to 7	7.94	2 to 3	1.82	1 to 3	1.58	9 to 10	9.76	.....	11.34	2to 3½	2.37	.....	2.37	.....	12.10	.....	26.73
9	.....	.....	7.99	.....	14.14	16.29	9.30	7.99	22.13	24.28	4.08	4.12	.....	.....	.....	8.38	.....	45.12
10	7.51	10.66	1.79	3.42	2.52	.....	.....	14.08	.....	14.38	2.68	3.08	.....	2.04	.....	10.44	.....	32.66
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.93	.....	7.84	.....	15.93
12	.....	11.41	.....	4.43	.....	0.30	.....	15.83	.....	16.14	.....	.....	.....	.....	.....	9.58	.....	14.58
13	.....	0.30	.....	7.90	.....	0.29	.....	8.20	.....	8.49	.....	2.19	.....	2.95	.....	7.81	.....	20.36
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.80	.....	.....	.....	9.71	.....	8.27	.....	16.95
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.28	.....	7.13	.....	1.62	.....	9.55	.....	14.34
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.97	.....	.....	.....	5.16	.....	0.00	.....	6.74
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.50	.....	.....	.....	0.91	.....	0.30	.....	2.11

	PHOSPHORIC ACID.										NITROGEN. N.		POTASH. K_2O		MOISTURE.		VALUE PER TON.	
	Soluble.		Reverted.		Insoluble.		Available.		Total.									
	Claimed	Found	Claimed	Found	Claimed	Found	Claimed	Found	Claimed	Found.	Claimed	Found	Claimed,	Found.	Claimed	Found	Price	Value
18	.....	1.36	.....	0.87	.....	3.30	.....	2.20	.....	5.51	.....	2.32	.....	1.02	.....	7.05	.....	17.05
19	.....	7.30	.....	2.22	1 to 2	0.26	8 to 10	9.50	.....	9.78	*2 to 3	1.91	$1\frac{1}{2}$ to $2\frac{1}{2}$	1.52	.....	9.32	.....	23.54
20	.....	.....	.....	.....	1 to 2	.....	.....	.....	.....	.....	.....	.....	12.0	12.71	.....	6.30	.....	12.71
21	.....	7.24	.....	1.62	.....	0.63	8 to 10	8.86	.....	9.49	*2 to 3	2.24	$1\frac{1}{2}$ to 2	2.17	.....	12.00	.....	24.84
22	.....	12.48	.....	1.44	.....	0.76	13.0	13.92	.....	14.68	.....	.....	.....	.....	.....	9.21	.....	23.34
23	.....	.....	.....	7.12	.....	15.33	.....	7.12	20to25	22.45	*4 to 5	3.73	.....	.....	.....	11.50	.....	45.51
24	.....	7.01	.....	1.92	.....	1.42	8 to 10	8.93	10to12	10.35	*3 to 4	2.98	2 to 3	2.60	.....	11.66	.....	29.00
25	.....	6.87	.....	1.83	.....	1.75	6 to 8	8.70	8 to 10	10.45	*2 to 3	3.02	1 to 2	1.92	.....	12.35	.....	28.76

* As Ammonia, NH_3

CEREALS.

A. E. MENKE.

WHEAT.

The work on wheat has been continued during the past year. Several new varieties were tested in addition to those that showed the most promise during the season of 1888. The results appended were obtained:

VARIETY.	YIELD BUSHELS PER ACRE IN 1888.	YIELD BUSHELS PER ACRE IN 1889.
Poole	25⅔	23⅓
Fultz	41⅓	33½ 35⅔
Early Rice	23	16
Med Hybrid	25⅔	21⅔
Fulcaster	30 5-6	24
Deitz Longberry	21½	19
Martin Amber	23⅓	13⅔
New Monarch	36 1-6	17⅓
Everitt's High Grade	31⅔	25
Golden Prolific	23½	19

The past season was not a very good one for wheat, and it will be noticed that a uniformly lower yield was obtained. The new varieties tested were sown on Sept. 25th.

VARIETY.	DATE HEADING.	DATE CUT.	YIELD STRAW POUNDS PER ACRE.	YIELD WHEAT BUSHELS PER ACRE.
White Mountain	May 3	June 10	1760	23⅓
Everitt's New Golden Cross	" 3	" 15	1680	21⅓
Ontario Wonder	" 10	" 11	1280	14
Michigan Amber	" 3	" 11	2280	26⅔
Velvet Chaff	" 3	" 10	2200	21⅔
Red Mediteranean	" 3	" 10	2080	17⅓
German Amber	" 3	" 14	2200	26
Michigan Bronze	" 7	" 15	760	8
Horsford Pearl				Failed.
Reliable	" 7	" 12	2380	19½
Sibley's Imperial	" 7	" 15	1800	18 1-6
Armstrong	" 7	" 14	1200	12⅔

DESCRIPTION OF WHEAT VARIETIES.

Golden Prolific—White with a slight amber tinge; stiff straw, ripens early, hardy.

Velvet Chaff—Heads large and compact; three to four grains in a mesh; red, hardy.

Deitz Longberry — White straw, white chaff, bearded wheat; stands well on rich ground, grains large, plump, solid, very flinty.

Everitt's High Grade—Beardless, white chaff, grain flinty red color. Straw bright, stands well.

Poole—Smooth heads, long, red berry, bright, stiff straw.

Hybrid Mediterranean—Grains dark red, short, plump, flinty.

New Monarch — Head long, set close, well filled; chaff white, grain large, dark red.

Golden Cross—Large, red, hard grain; bearded, red chaff. Cross between Mediterranean and Clawsen.

Armstrong—Large, white wheat, beardless, stiff straw.

Michigan Amber—Grains amber, hard and flinty; straw bright and tough.

Martin Amber—Grains amber, flinty, heads long, straw bright and tough.

The other varieties were described last year.

From the results of experiments made to date, we are inclined to recommend *Fultz* and *Michigan Amber* as varieties suited to the northwestern section of the State. They both gave larger yields than any other variety, withstood storms better and were in every other way most desirable. Naturally this advice is subject to change later, as two years' observation is not sufficient to settle the question absolutely. An experiment on the preliminary cultivation of wheat land made by Mr. R. A. Robinson, a careful farmer in the northern portion of the State, is of considerable interest, and although the results were about what might have been expected, we deem it worthy of insertion. The variety used was *Fultz*.

Land plowed once yielded	16	bushels	to the acre.
Plowed and harrowed once yielded	18½	"	" "
Plowed twice and harrowed once yielded	21⅔	"	" "
Plowed and harrowed twice yielded	23¼	"	" "

The work on fertilizing wheat land was contiued from last year. The results then obtained indicating the value of a nitrogenous fertilizer, were confirmed this year.

It appears, taking freight rates, etc., into consideration that the most economic fertilizer is two hundred to two hundred and fifty pounds of cotton seed meal to the acre.

The results in detail were as follows:

POUNDS FERTILIZER PER ACRE.	INCREASE YIELD BUS. PER ACRE, VALUE 65 CENTS.	INCREASE STRAW LBS. PER ACRE VAL. $6 PER TON	COST FERTILIZER	PROFIT.	LOSS.
200 Kainit, 340 Acid Phosphate, 280 Sodic Nitrate	9	1080	$6 60	$2 49	$
200 Kainit, 340 Acid Phosphate, 280 Sodic Nitrate	10 2-3	1040	6 60	3 46	
200 Kainit, 340 Acid Phosphate	8 2-3	840	3 24	4 92	
200 Kainit, 280 Sodic Nitrate	8 2-3	440	4 36	2 60	
340 Acid Phosphate, 280 Sodic Nitrate	8 1-3	1280	5 60	3 66	
340 Acid Phosphate	2 2-3	160	2 24		02
280 Sodic Nitrate	7 2-3	680	3 36	3 67	
200 Kainit	2-3	160	1 00		08
400 Floats	6	480	2 40	2 94	
400 Cotton seed meal	6 2-3	520	3 00	2 90	
200 Cotton seed meal	9	620	1 50	6 21	
600 Cotton seed meal	8	680	4 50	2 74	

OATS.

We have had fair success with winter oats in the northwestern portion of the State, and can recommend the *Black Russian* as a variety giving a good yield, splendid straw and grain, weighing forty pounds to the bushel. Experiments on oats with fertilizers showed, in only two instances, balances on the right side. The following are the results in detail:

POUNDS FERTILIZER PER ACRE.	DATE SOWN.	DATE CUT.	YIELD, BUSHELS. OATS 40 LBS. TO BUSHEL.	YIELD STRAW POUNDS.	COST OF FERTILIZER.	PROFIT OVER UNFERTILIZED.	LOSS.
250 Acid Phosphate 300 Sodic Nitrate	Sept. 29	May 29	48¾	1920	$10 62	.....	$ 7 57
250 Acid Phosphate. 250 Sodic Nitrate....	.....	.....	46½	1660	8 80	.....	6 20
200 Floats. 200 Sodic Nitrate....	.....	May 31	52½	2100	7 20	.....	3 40
250 Acid Phosphate.....	.....	.....	50¾	1840	1 62	1 83	.....
200 Sodic Nitrate.....	.....	.....	50¼	1800	6 00	.....	2 65
200 Kainit.....	.....	.....	43	1460	1 40	50	.....
250 Cotton seed meal...	.....	.....	42¾	1400	1 90	.....	05
Nothing	.....	.....	33½	1200	.....	.....	.....

It is evident from the above figures, that some different mixture must be used, and we now have other tests under way in different parts of the State. The effects on worn cotton land will be interesting. Mr. C. B. Collingwood has made determinations of the per cents. of Nitrogen and Ash, also of the weights of the grains in water to show how commercial fertilizers affect oats.

FERTILIZER USED, POUNDS PER ACRE.	PER CENT. NITROGEN.	PER CENT. CRUDE PROTEIN.	PER CENT. ASH.	PER CENT. MOISTURE.	WEIGHT OF 100 GRAINS IN GRAMMES.
250 Acid Phosphate. 300 Sodic Nitrate.	1.46	9.12	3,76	10.53	2.876
250 Acid Phosphate 250 Sodic Nitrate.	1.49	9.31	3,87	11.14	2.740
200 Floats. 200 Sodic Nitrate.	1.48	9.25	4.05	10.60	2.871
250 Acid Phosphate.	1.59	9.93	3.68	10.16	2.767
200 Sodic Nitrate	1.50	9.37	3.43	10.44	2.679
200 Kainit	1.43	8.94	3.49	9.50	2.598
250 Cotton Seed Meal	1.59	9.93	3.43	11.20	2.743
Nothing	1.43	8.94	3.48	10.65	2.736

CORN.

We have continued our experiments on corn at Fayetteville and Pine Bluff, making particular notice of tests of varieties and the general economic effects of fertilizers.

The following is a description of the kinds worked with:

Early Eclipse—A cross between Leaming, Riley's Favorite and Illinois Premium Dent. Ear averages about nine inches in length; grain long, deeply dented; color, orange yellow.

Leaming—A yellow Dent variety; small red cob, with a deep, long grain.

Golden Beauty—Ear well shaped, with from ten to fourteen rows of bright yellow grains of good size.

Hickory King—A white Dent, with ears about seven inches long and from five to six inches in circumference; a good bearer.

Piasa King—A hybrid of St. Charles and a late White Dent. Ear long and tapering; from nine to fourteen inches in length; grain long, white and deeply dented; well suited for bottom land.

Piasa Queen—Ear large; grain yellow, deeply dented; stalk strong and healthy.

White Giant Normandy—This variety has yielded well with us for two years in succession. It is a late white Dent; grain very large; stands drought well.

Champion Early White Pearl—An early white Dent.

Rowel Corn—A good sized variety from Georgia.

Brooks' Native—An excellent variety with large grain and very small cob.

TEST OF VARIETIES OF CORN AT FAYETTEVILLE.

VARIETY.	PLANTED.	TASSELED.	ROASTING EAR.	GATHERED.	BUS. PER ACRE.
Early Eclipse	April 6	June 20	July 12	Oct. 28	42 1-3
Rowel Corn	"	July 10	" 25	" 28	47 2-9
Queen of the Prairie	"	June 20	" 9	Nov. 4	48 2-3
King Phillip	"	May 15			Failed.
Early Wisconsin	"	June 20	July 15	" 4	44 5-18
Murdock's 90 Day	"	July 1	" 19	" 5	44 2-3
Leaming Yellow	"	"	" 19	" 5	44 2-9
Golden Beauty	"	"	" 19	" 5	43 3-4
Brooks', *Native*	"	July 10	" 24	" 5	54 1-6
Blunt's Prolific	"	" 5	" 24	" 5	41 2-3
Naylor's Imp. Prolific	"	" 1	" 21	" 13	45 5-18
Late Calico	"	" 12		" 13	44 2-9
St. Charles White	"	" 12		" 13	43 1-18
Hickory King	"	" 15		" 14	45
Large Gourd Seed, *Native*	"	" 12		" 14	49
Mammoth White Surpise	April 8	" 5		" 14	51 7-18
White Giant Normandy	"	" 1	July 20	" 14	70
Shield's Stooling Flour	"	" 10	" 25	" 9	36 1-4
Late Piasa King	"	" 10		" 9	55 5-18
Champion Early White Pearl	"	June 24	July 15	" 6	44 4-9
Mosby's Prolific	"	July 10		" 6	58 5-18
Piasa Queen, yellow	"	" 5	July 20	" 6	55 1-3
Late Piasa Pet	"	" 5	" 24		54 1-6

RESULTS OF TWO YEARS' TESTS.

	1888. BUS. PER ACRE.	1889. BUS. PER ACRE.
White Giant Normandy	60	70
New Hickory King	48	45
Golden Beauty	46.6	44.2
Blount's Prolific	50.5	54.1

TEST OF VARIETIES OF CORN AT PINE BLUFF.

The corn was planted April 6, in rows four feet wide, with the following results:

VARIETY.	FIRST SILK.	YIELD BUS. PER ACRE
Tuscarora	June 11	16.3
Queen of Farm, white	" 17	20.9
Compton Early "	" 17	poor
King Philip, red	" 17	"
Chester Co. Mammoth, yellow	" 17	25.4
Top Over, white	" 10	poor
Reddish Flint	" 11	"
Silver White Flint	" 11	"
Prince Charles, white	" 21	42
Early Yellow, six weeks	May 27	poor
Golden Beauty, yellow	June 18	26.8
Pride of the North, yellow	" 6	poor
Hickory King, white	" 24	32
Ensilage Corn, "	" 24	30
Blunt's Prolific, "	" 24	33
Champion Early White Pearl	" 17	27.9
Piasa King, white	" 28	34.9
Ind. White Gourd Seed	" 10	19.2
Sweet Fodder, white	May 28	poor
Evans, red	June 17	30.9
Queen, yellow	" 28	32.3
Leaming, yellow	" 17	22.4
Golden Dent	" 24	24.7
Native Shoe Peg	" 27	32.6

EXPERIMENTS WITH COMMERCIAL FERTILIZERS ON CORN.

The undermentioned record shows the results of our first year's tests of fertilizers on corn. As this is a question that will take continued work to answer, it is merely given as a report of progress. The table is self-explanatory. The corn was planted in the usual way on April 2d and 3rd, 1889. Corn sold at 25c. per bushel.

POUNDS PER ACRE FERTILIZERS USED.	DATE TASSEL	ROASTING EAR	Bus. Incr'sd Y'ld per acre over unfrtld 25c. per bu.	Cost of Fertilizers.	PROFIT.	LOSS.
200 Acid Phosphate	July 14	July 30	14	$ 1.36	$ 2.14	$
200 Floats	" 15	" 30	2 2-3	1.20	.....	0.54
200 Sodic Nitrate	" 15	" 30	20 2-3	2.40	2.76	
100 Sodic Nitrate 100 Acid Phosphate	" 16	" 28	13 4-9	1.86	1.51	
100 Sodic Nitrate 100 Floats	" 16	Aug. 2	9 5-9	1.80	.60	
200 Kainit	" 16	" 2	12 1-3	1.00	2.08	
100 Kainit 100 Acid Phosphate	" 11	July 30	21 7-9	1.16	4.30	
100 Kainit 100 Floats	" 16	" 30	9 5-9	1.10	1.30	
250 Cotton Seed Meal	" 11	" 28	29	1.90	5.35	
250 Cotton Seed Meal 200 Acid Phosphate	" 15	Aug. 2	37 1-3	3.26	6.07	
250 Cotton Seed Meal 200 Floats	" 16	" 2	29	3.10	4.15	
250 Cotton Seed Meal 200 Kainit	" 11	July 30	23 4-9	2.90	2.97	
250 Cotton Seed Meal 200 Kainit 200 Superphosphate	" 11	Aug. 2	40 1-9	4.90	5.13	
250 Cotton Seed Meal 200 Kainit 200 Acid Phosphate	" 11	July 28	54	4.26	9.24	
250 Cotton Seed Meal 200 Floats 200 Kainit	" 16	Aug. 2	36 7-9	4.10	5.11	
200 Dried Blood	" 16	" 2	29	4.22	3.03	
100 Dried Blood	" 16	" 2	20 2-5	2.11	3.05	
200 Dried Blood 200 Acid Phosphate	" 14	July 30	40 1-9	5.58	4.45	
200 Dried Blood 200 Kainit	" 16	Aug. 2	34 5-9	5.22	3.43	
200 Dried Blood 200 Floats	" 16	" 2	35	5.42	3.33	
200 Dried Blood 200 Acid Phosphate 200 Kainit	" 17	" 4	29	6.58	.67	
200 Dried Blood 200 Floats 200 Kainit	" 17	" 2	26 1-12	6.42	.10	
20 Loads Barnyard	" 14	" 2	40	10.00	00	.00

POTATOES.

A. E. MENKE.

The subject of potato growing is becoming more and more important in portions of the State; the increased shipments to Texas are drawing the attention of our farmers to its value. We have made extensive tests of varieties, the results of which will be found in the accompanying tables. We have also experimented somewhat on methods of planting. These latter tests can at present be only regarded as tentative. Probably the most common method of planting potatoes is after the soil is prepared, to furrow out to the depth of from three to five inches with a small plow, then drop the seed along the furrow and cover with a ridger, plow or hoe. Some of the lately invented potato planters will save a great amount of time and considerable money on the first cost of the crop as with a planter and pair of horses, an ordinary driver can do the work of many men. We have tried the Carman plan of planting with fairly good results. The method is: Trench out the soil with a shovel plow. By running twice it gives a depth of from seven to nine inches; the potato seed cut to three strong eyes is placed on the bottom, one foot apart in the row; a plank drag is now used to cover them to a depth of about three inches of soil. Upon this the fertilizer used is strewn. The trenches may so remain until the first cultivation, when that will fill them, or a furrow may be turned on either side. In our experiments, we used different fertilizers, and prefer to withhold any suggestions on what to use until confirmatory results have been obtained. We can, however, state that the yield obtained from this system averaged *33 per cent.* higher than the usual mode.

TESTS OF VARIETIES.

VARIETY.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Akron	April 4	June 28	400
American Monarch	"	30	182
American Wonder	"	28	140
Augusta's Favorite	"	"	174
Acme	"	"	160
Bliss No. 30	"	24	205
Brownell's No. 55	"	28	180
Biscuit	"	"	240
Breeze	"	30	200
Brownell's No. 1	"	28	137
Buffalo Beauty	"	30	280
Brook's Seedling	"	"	268
Black Nechanock	"	28	170
Black Rose	"	"	80
Blue's Early	"	24	140
Bloodhart	"	30	83
Bonanza Red	"	28	227
Beauty of Sheba	"	May 28	160
Baraboo White	"	"	168
Bemis Height	"	30	120
Breeze No 7	"	"	180
Brownell's Wideawake	"	"	170
Bliss' Triumph	"	"	300
Bingham	"	"	272
Blue Chenango	"	"	272
Brother Jonathan	"	30	156
Beauty of the West	5	26	266
Beauty of Rochester	"	24	200

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Barker's Imperial	April 5	May 21	272
Chattanooga	" 4	June 24	233
Cook's Seeding			
Chicago Sun	April 4	" 28	171
Calico	"	" 30	50
Crawford	"	" 24	190
Conquest	"	" 28	152
Crimson Beauty	"	" "	171
Carter	"	" "	217
Cayuga	"	" "	250
Canada Wonder	"	May 30	106
Champlain Seedling	"	" "	112
Canada Blue	"	" 28	160
Cook's Seedling	"	" "	71
Columbus Excelsior	"	" 24	180
Charley Ross	"	" "	140
Canada Prince Albert	"	" "	128
Champion	"	" 28	170
Cowle's Seedling	"	" 24	140
Champlaine	"	" 28	251
C. of W. Victory	"	" 24	160
Calmer No. 2	"	" 30	229
Crimson Monarch	"	" "	300
Crown Jewel	"	" 24	160
Cream of the Field	"	" 21	235
Canada Seedling	"	" 24	195
Cook's Seedling	"	" 24	135
Cala Peachblow	" 5	" 21	66

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Jordan's Prolific	April 4	June 24	102
Junks	"	May 28	170
King of Potatoes	"	24	102
King of the Hills	"	"	145
Knapp's Snowbank	"	28	256
King of Kings	"	"	229
Ladyfinger	"	June 24	250
Ledding's Seedling	"	May 24	120
Little Giant	"	30	196
Lion	"	28	92
Murry's Goldflake	"	28	149
Mitchell's Seedling	"	30	140
Mormon	"	28	300
Marshal	"	"	226
Mayflower	"	"	151
Michigan White	"	"	127
Magnum Pinkeye	"	24	320
Morris White	"	28	96
Mammoth	"	"	74
Marvel of Beauty	"	24	213
Morning Star	"	"	70
Michigan Rose	"	24	174
Manhattan	"	30	145
Mrs. Foraker	"	24	60
Maine's Champion Blaine	"	"	157
Monarch	5	26	188
Matchless	"	29	141
No. 140	4	30	120

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Nova Scotia	April 4	May 24	160
Nameless	"	28	44
New Roxen	"	24	22
North Star	"	21	128
New Yorker	"	30	251
Old Long Mercer	"	June 30	113
Old English White	"	May 28	144
Olin Queen.	"	"	140
Old Orange Pinkeye	"	24	220
Pride of America	"	June 10	154
Pride of Japan	"	24	204
Purple Blush	"	28	47
Perfection Kidney	"	"	70
Putnam's Rose	"	"	150
Pride of the Field	"	24	98
Peruvian	"	28	200
Pink Eye Snowflake	"	May 24	120
Poughkeepsie White	"	28	160
President Cleveland	"	24	200
Perfect Gem	"	30	147
Potter's Seedling	"	"	140
Purple Blush	"		111
Pastatuck	"	24	120
Polaris	"	"	171
President Arthur	"	30	40
Penna Belle	"	24	128
Peerless Peachblow	"	"	120
Pride of Lisdom	"	"	192

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Quenybelle	April 4	June 30	217
Quaker City	"	May 28	160
Rogers No. 7	"	28	245
Rogers No. 7	"	30	237
Red Whicler	"	28	187
Rose's Moon	"	June 24	248
Red Puritan	"	28	133
Rochester Favorite	"	30	164
Rose's Seedling	"	28	156
Red Gypsy	"	"	127
Rocky Mountain Rose	"	May 24	192
Richer's Graft	"	"	127
Rose's Elephant	"	"	165
Rand's No. 42	"	30	72
Rhinebeck	"	24	193
Red King	"	"	156
Randall Rose	"	"	302
Rose's New Seedling	5	26	187
Red Stem	"	28	155
Spot of Brunswick	4	June 30	183
Story's Seedling	"	28	198
Spauldings	"	"	167
Sterling	"	24	252
Silver Chili	"	30	240
Steve's No. 1	"	"	67
Spanish Main	"	28	213
Seek no Further	"	"	195
Stanton	"	24	195

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
Snowdrop	April 4	June 30	144
Shaker Fancy	"	"	151
Sunlit Star	"	"	80
Scotch Blue	"	May 28	160
Sport of White Elephant	"	21	200
Slammans Seedling	"	30	160
Stray Beauty	"	"	116
State of Maine	"	24	177
Sir Isaac	"	30	204
Syrian Purple	"	"	200
Shaker's Surprise	"	28	132
Sutton's Red Flake	"	June 10	135
Stone's Seedling	April 5	May 24	111
Slumber Chief	"	"	266
Sariana	"	26	145
Victor	"	June 28	192
Vermont Champion	"	"	180
Virgor of Alvoy	"	30	160
Winslow's Seedling	"	24	150
Wood Ants	"	30	160
Wood Ants	"	May 28	240
White Seedling	"	28	248
Woodberry's Late Favorite	"	"	50
Whipple's Seedling	"	30	132
Well's Early	"	24	64
West's Seedling	"	"	160
Woodberry's White Sprout	"	"	157
Well's No. 1	"	28	166

TESTS OF VARIETIES.

VARIETIES.	DATE OF PLANTING.	BLOOMED.	YIELD BUSHELS PER ACRE.
White Rose	April 4	May 30	187
White Boston Market	"	30	156
Well's No, 40	"	28	176
Well's No. 40	"	"	121
Woodberry's White Sprout	"	24	157
Wall's Orange	"	"	205
White Lilly	"	28	109
Yosemite	"	24	126
Zacheus	"	24	183

YIELD OF POTATOES PLANTED IN DIFFERENT WAYS.

VARIETY.	PLANTED.	BLOOMED.	DRIED.	DRY.	WEIGHT PER BUS.	YIELD BUS. PER ACRE ORDINARY CUT.	PER CENT. SMALL.	YIELD BUS. PER ACRE, CUT TO THREE EYES.	PER CENT. SMALL.
Chas. Downing	Mar. 27	May 22	July 5	July 19	59	103	12½	96⅔	16
Thorburn		20	15		59½	224 1-6	17	241	10
Seneca Beauty		28	5			123 5-6	10	133⅓	8
Vick's Gem		21	June 24			240	12½	227	10
Ohio Junior		21	July 5	Oct. 11		125		120	
Empire State		17	10	5		176		158⅓	
Beauty of Hebron		21	5	5		150		142	
Lady Finger		24	June 24	11	60	52⅓	50	50 5-6	50
American Giant	May 21		July 5	Sept. 5	58	131⅔	10	131⅔	8½
Alexander's Prolific		18	10	Aug. 29		165	14	180	9
Clark's No. 1		21	5			150		145	
Early Ohio		May 30				70		90	
Badger State		28				78⅓		103	
Lee's Favorite		21				93⅓		95	
Chicago Market		21				90		80	
Puritan	Mar. 28	20	June 28			103⅔		91⅔	
Pearl of Savoy		24				80		98	
Early Oxford		21	July 5			108	7	124	5
Queen of Valley		21				120	5	135	6
Early Maine		21				131		124	
Sunlit Star		17	June 24			123⅓		140	
Golden Kidney			July 5			55		62	
Hall's Early Peachblow		4	5			90		110	
Garfield		21	15			220	12	160	12
Dakota Red		18	June 24			121⅔		116⅔	
White Elephant		21	July 11			131		121	
Burpee's Superior			15			174		183½	
Mammoth Pearl		June 5	15			152		165	
Vick's Extra Early	Mar. 28	May 30	June 24				91	25	115

YIELD OF POTATOES PLANTED IN DIFFERENT WAYS.—Continued.

VARIETY.	PLANTED.	BLOOMED.	DRIED.	DRY.	WEIGHT PER BUS.	YIELD BUS. PER ACRE ORDINARY CUT.	PER CENT. SMALL.	YIELD BUS. PER ACRE, CUT TO THREE EYES	PER CENT. SMALL.
Early Albino		May 30	24			71	16	70½	
Mammoth Prolique	April 4	10	30	Aug. 6		126⅔		90⅔	
Landreth's State Me		10	30	6		201⅔		160	
Great Eastern		15	20	6		79		93	
Landreth's Garfield		15	10	6		80⅔		71	
Snow Queen		5	10	6		101		123	
Green Mountain	11	20	15	6		196		208	
Vanguard	Mar. 28	24	June 10	Oct. 17		175		160	
Early Standard	28	24	July 5			132		140	
White Star	28		5			233		198	
Gold Flesh	28		5			168		155	
Rural New Yorker	25		June 20	Aug. 14		102		133	
Burbank Seedling	25	May 24	June 24	15		135		121	
Early Sunrise	28	21	July 5			83⅓		98⅓	
Snow Flake	28		June 30			130		146⅔	

KEEPING QUALITIES OF DIFFERENT VARIETIES.

The undermentioned list of potatoes were kept in a rock house during the winter, and on March 19, 1889, showed the following percentages rotten:

VARIETY.	PER CENT. ROTTEN.	VARIETY.	PER CENT. ROTTEN.	VARIETY.	PER CENT. ROTTEN.
Chicago Market	75	American Giant	3	Early Albino	10
Queen of the Valley	50	Lee's Favorite	60	Thorburn	50
Hall's Early Peachblow	10	Early Harvest	25	Alexander's Prolific	20
Clark's No. 1	5	Empire State	20	White Star	20
Rose's Wild Rose	50	Dakota Red	90	Beauty of Hebron	60
Rose's New Giant	10	Rural Blush	90	Burbank	10
Early Ohio	5	Home Comfort	50	White Elephant	20
Rose's Beauty of Beauties	5	Early Telephone	25	Chas Downing	10
		Pearl Savoy	10		

GRASSES.

A. E. MENKE AND R. L. BENNETT.

The subject of grasses for hay and pasture has come to the front in this State as a leading factor in successful agricultural practice. In order to test what grasses will grow on worn cotton lands, we have sown some thirty acres with different varieties of grasses and clovers alone and in various mixtures, fertilized and unfertilized. A brief description is appended of the more uncommon varieties. The land on which they were sown is a sandy soil that is said to have been in cultivation in cotton for thirty-five years. It is a typical soil and well suited to the tests contemplated. Plots, *one-half acre each*.

SOWN FEB. 23.	AMT. SOWN TO THE HALF ACRE.	CONDITION OCT. 2	RESOWN OCT. 20.	CONDITION DEC. 31.
Ky. Blue Grass	1¼ Bushels	Poor	No	2-3in. High.
Red Top	1	Fair	No	2-3 "
Meadow Fescue	¾	Fair	No	3-4 "
Perennial Rye	¾	Fair	No	2½-4 "
Orchard Grass	1	Bad	Yes	1-1½ "
Tall Meadow Oat	1	Bad	Yes	1-3 "
R. I. Bent	1	Fair	No	2-3 "
Fiorin	1	Fair	No	2-3 "
Meadow Soft	2	Bad	Yes	1-2 "
English Rye	1½	Bad	Yes	2-2½ "
Texas Blue Grass	1	Bad	Yes	
Timothy.	7½ Pounds	Bad	Yes	1-2 "
Sweet Vernal	5	Bad	Yes	1 "
Italian Rye	12½	Bad	Yes	2-3½ "
Sheep Fescue	7½	Bad	Yes	½-1 "
Teosinte	1½	Good	No	Dead.
Alsike	4	Fair	No	5-7in. High.
Alfalfa	7½	Poor	Yes	1-2½ "
Meadow Foxtail	12½	Poor	Yes	2-3 "
Bermuda	2½	Good	No	
Crested Dogstail	12½	Poor	Yes	1-2 "
Hard Fescue.	15	Fair	No	2-3½ "
Tall Fescue	20	Fair	No	3-6 "
Red Fescue	12½	Poor	Yes	1-2 "
Canada Blue Grass	14	Bad	Yes	½-1 "
Wood Meadow	15	Poor	Yes	1-1½ "
Rough Stalked Meadow	10	Fair	No	
Slender Foxtail	10	Bad	Yes	½ "
Japan Clover	20	Very Good	No	
Seredella	20	Poor	Yes	1 "
Yellow Trefoil	7½	Poor	Yes	½ "
Lupine.	7½	Poor	Yes	3-3½ "
Texas Blue Grass	1 Bushel		No	

Some of the plots were duplicated and fertilized. The effect of the fertilizers is shown by the increased growth.

VARIETY.	FERTILIZER POUNDS PER ACRE.	INCREAS'D GROWTH ON UNFERTILIZED ON DEC. 31.
Italian Rye	360 floats, 360 Kainit	1-1½ inches.
Orchard Grass	300 Sodic Nitrate	3-6 "
Perennial Rye	180 Acid Phosphate, 180 Cottonseed Meal	1½-3 "
Red Top	750 Floats	1 "
" "	750 Kainit	" "
" "	750 Cottonseed Meal	" "
Tall Meadow Oat	200 Sodic Nitrate, 200 Acid Phosphate	2-2½ "
Blue Grass	750 Acid Phosphate	2-4 "
" "	750 Kainit	2-3 "
" "	750 Cottonseed Meal	2-3 "
Meadow Fescue	360 Floats	½-1 "
" "	360 Kainit	1 "
" "	360 Cottonseed Meal	1 "

The mixed pastures are doing very well generally, having at this date a height of from one to seven inches. We have been informed many times that our tame grasses would not grow on worn Arkansas cotton lands, but it is evident some of them will. Those grasses that were reset had been either smothered out by crab grass or killed by drought. This chapter on our grass experiments is written in accordance with the desire of the White River Stock Association and is merely a report of progress.

FIELD NOTES ON GRASSES.

Fifty-one plats were sown to different varieties of grasses in spring of 1889 and twenty-six of them were resown in October. The following notes were made and will be continued at such times as thought best and the changes of the condition of the grasses warrant them.

November 15. The many heavy rains and hard freezes from November 1–15 continually changing the temperature, were greatly detrimental to the grasses, and especially to those resown in October which were germinating, and the result of which a very poor stand has been obtained up to this time, and the grasses sown in the spring have not made much growth.

November 30. The very bad weather which prevailed during the first part of November continued up to this date; hence the condition of grasses has changed very little; on resown plats a very small per cent. better stand has been obtained.

December 15. The resown plats have produced a good growth and almost a perfect stand; only few to the contrary. Since November 30th, weather has been very fine and warm, but notwithstanding these facts a large number of the spring sown grasses have produced very little growth, if any, while a few have done moderately well.

December 31. Throughout December the weather has been remarkably fine, yet the majority of the spring sown grasses have not produced any growth, but on the contrary seem to have decreased while a majority of the resown grasses have grown very rapidly.

December 31. The height and condition of the grasses at this date is shown in the tabular report.

VARIETIES OF GRASSES.

The following is a brief compiled description of varieties of grasses tested:

Sweet Vernal—This grass does not rank as high as some others for nutritive qualities, yet animals like it. It is sown, usually, for the purpose of flavoring hay, as it has a pleasant, aromatic odor. The culms being wide apart, thin and bearing few leaves, causes it to give a light crop, rarely over three-quarters of a ton to the acre. It is profitless sown alone, and should always be mixed with other grasses for meadow or pasture. It is perennial and hardy, growing one to two feet high. Its growth is discouraged by highly nitrogenous and farm yard manures.

Italian Rye Grass—One of our most valuable grasses. It stands drought well, and grows luxuriantly in the South. Animals are very fond of it. It grows two to three feet high; the leaves are abundant, dark green, with a metalic lustre; the whole plant being tender and nutritious. The stems have peculiar, small spikes with the appearance of little brushes. This

grass will bear many mowings, and sometimes yield as high as seven tons of dry hay to the acre.

Perennial Rye—This grass makes good hay and good grazing, but it is not well suited for permanent pasture and meadow. It grows best in a rich, moist soil, and does not stand drought well. Although named perennial, it rarely lasts more than from three to five years. The stem is from one to two feet high, has four to six purplish joints, and as many dark green leaves. It has a straight spike at the top, giving it the appearance of quack grass.

Rhode Island Bent Grass—Belongs to the same family as Red Top, and has the appearance of being a small plant of that grass. It is peculiarly adapted for lawns and makes a close sod. It is rather too small to afford much feed for cattle.

Crested Dogstail—A deep-rooted grass that has not met with much favor; it is quite nutritious, but is short and soon becomes hard. It is fairly suited for sheep. The culms becoming wiry, the quality of the hay is poor.

Meadow Foxtail—A valuable grass, well suited to moist, rich soil. It looks something like Timothy; the plant being generally softer with shorter and broader spikes. It grows from two to three feet high, but does not attain perfection until two or three years old.

Wood Meadow Grass—Suited to moist places. It is quite nutritious, well liked by cattle; the stems are slender and from eighteen inches to two feet high.

Rough Stalked Meadow Grass—Has very much the appearance of Blue Grass, but has rougher culms and sheathes; it is suited to a deep, moist loam, and does best in shaded pastures. It is perennial, highly nutritious and well liked by cattle.

Texas Blue Grass—Prof. Shelton says that as far north as Kansas, this grass endures the winters and resists drought perfectly, making three or four times as much pasture or hay as Kentucky Blue Grass.

Meadow Soft Grass—A grass of very attractive appearance, being variegated in tint. It produces well in poor, sandy

soils; is quite nutritious, but is not a favorite with cattle. It grows from two to four feet in height, and is an abundant yielder.

Bermuda Grass—Dr. Phares remarks of this valuable grass: "As a permanent pasture, I know of no other that is so valuable as this." On good land it cuts from two to four tons of excellent hay. It is not suited for plantations having indolent owners. It grows from ten to fifteen inches high, and to make good hay should be mowed three to five times every summer.

Meadow Fescue—This grass yields from two to four tons of hay to the acre, and will grow on almost any kind of soil. The stems are two to three feet high, with long, tender leaves. It is well relished by cattle, and having long fibrous roots, is protected against droughts.

Red Fescue—Is well suited to dry, sandy soils; grows from two to three feet high; stands the drought well.

Tall Fescue—A perennial, grows from two to four feet high; the roots are woody and it does not suffer from drought. It is a coarse grass, but is well liked by stock. It does not attain full productive powers until the third year from sowing.

Hard Fescue—Is said to be a good pasture grass; stands the drought well and grows from one to two feet high.

Sheep Fescue—A small perennial, grows from six to twelve inches high; suited to dry, hilly pastures; sheep do well on it.

Tall Meadow Oat—This grass has very much the appearance of common oats, but is more slender. It grows from two to seven feet high, depending on the soil. It has long, fibrous roots, and is but little affected by drought. It is a hardy perennial, and can be cut twice a year. It has a bitter taste, which is occasionally objectionable to stock.

Sainfoin—A leguminous plant that is said to bring up the fertility of poor soil. It lasts four to seven years.

Alfalfa—This plant comes nearer being draught proof than any other. It has long, fibrous roots that sometimes go twenty feet into the ground. It produces a large amount of nutritious foodstuff, containing a high percentage of protein. It

grows best in a rich loam or land with a dry, porous subsoil. It should never be pastured, live stock bite out the culms and kill it.

Yellow Lupine—A plant with a very bitter taste, eaten by sheep only.

Japan Clover—Is a low perennial plant not rising much above the ground but spreading widely on the surface. It grows about twelve inches high and does well on any soil. It is highly nutritious, and, although stock may not like it at first, they ultimately leave other pasture for it.

Alsike Clover—A perennial clover, stands dry weather well. It takes two or three years to attain full growth. Makes good pasturage; looks as though it might be a hybrid between red and white clover; it is not, however.

Teosinte—This plant in many ways resembles corn. It has large leaves and grows from six to fifteen feet high. It is highly relished by cattle and is an enormous yielder. It is easily killed by frost.

Timothy, Orchard Grass, Kentucky Blue Grass and Red Top, are too well known to need description.

COTTON.

PINE BLUFF BRANCH EXPERIMENT STATION.

A. F. CORY AND A. E. MENKE.

How to produce more profitable crops on our worn soils is a question of growing importance to the people of Arkansas. It is already a question of vital importance to the hill farmers, and each year brings it nearer home to the planters of our rich bottoms.

Wherever the land has been in cultivation for any length of time, this question inevitably arises.

No matter how fertile a soil may be, continued cultivation will exhaust it, and sooner or later some means must be found of restoring it to fertility, This question has been asked in the older states, and in some parts of our own State, and a probable solution to it found in the use of commercial fertilizers.

The use of commercial fertilizers is not, however, the only means that should be employed in restoring the fertility of our worn soils. There is no better fertilizer than stable and barnyard manure. Rotation of crops is an important aid in maintaining fertility, and a great deal can be done in this direction by planting crops like peas or clover and either turning them under green or allowing them to decay on the surface. If we could keep up the fertility of our soils by this means, the saving of stable manure, rotation of crops, and the planting of peas or clover, there would be no necessity for the use of commercial fertilizers. But these means, by themselves, have not been found sufficient, and this deficiency should be made up by the use of commercial fertilizers.

The elements which worn soils usually need are Nitrogen, Potash and Phosphoric acid. The principal sources of Ni-

trogen are cotton seed meal, stable manure and guano. The principal sources of Phosphoric acid are the phosphates and bone meal. The principal sources of Potash are Kainit and wood ashes.

Some soils, need Nitrogen, some Potash and some Phosphoric Acid; some need Nitrogen and Potash, some Nitrogen and Phosphoric Acid, and some need all three of these elements. Different soils need different fertilizers; the need depending part on the compositions of the soil and partly on its previous treatment. This fact is well illustrated by experiments conducted in different parts of the State in 1888.

At the branch experiment station at Texarkana, Potash and Phosphoric Acid were used at a profit. Experiments conducted by Mr. W. P. Hale at Lufra, Ouachita county, went to show that the soil at that place needed the same fertilizers as that at Texarkana. Experiments made by Mr. F. M. Bordeaux at Monticello, Drew county, showed that Nitrogen, Potash and Phosphoric Acid, could all be used with profit at that place, while experiments at this place showed that only nitrogenous manure could be used with profit.

But while it is true that different soils need different fertilizers, it is also true that experiments conducted on any one class or character of soil are reasonably sure to hold good for soils of a similar character. It is on this fact that much of the value of the following experiments to the farmers, depends.

The object of the experiments on cotton with fertilizers has been to ascertain, if possible, what fertilizers were needed by our worn soils, and to place such information within the reach of the farmer as will enable him to use fertilizers intelligently.

The land on which the station is located has been in cultivation for thirty years. During this time it has been almost continuously planted in cotton, and as it is some distance from the gin-house, it has probably not received any manuring. At present nine hundred pounds of seed cotton to the acre is regarded as a good yield under favorable circumstances.

The first three sets of experiments occupy one acre of

land, and are separated from each other only by blanks. Thus blank number 5 of set I., also appears as blank number 5 of set II.

SET I.

Object: To ascertain whether the soil is deficient in nitrogen, potash or phosphoric acid. Soil: Sandy bottom, with a slightly richer depression running nearly at right angles across the plats.

Arrangement: Rows three and one-half feet wide by seventy yards long; four rows equal to one-fifteenth acre used for each experiment. Planted: April 19th, coming up April 25th.

	POUNDS SEED COTTON PER ACRE.	INCREASE PER ACRE.	VALUE OF INCREASE.	COST OF FERTILIZER.	PROFIT FROM USE OF FERTILIZERS.	LOSS FROM USE OF FERTILIZER.
Plat 1, Blank	780					
" 2, 300 lbs. Cotton Seed Meal	1189	318	$7 95	$3 00	$4 95	
" 3, 350 lbs. Acid Phospoate	1005	60	1 50	3 50		$2 00
" 4, 350 lbs. Kainit	990	30	75	1 75		1 50
" 5, Blank	1110					

There is a nearly uniform increase in fertility from plat 1 to plat 5. It would be unfair to compare the yield of all fertilized plats with the yield of plat 1, because it is less fertile than any of them. It would be equally unfair to compare them with No. 5, for they are all less fertile than this plat. This difficulty has been obviated in the following manner: Plat three is equally distant from No.'s 1 and 5. If now we add the yields of 1 and 5, and divide the sum by two, we will get what would have been the yield of plat 3 without any fertilizer. This result subtracted from the actual yield of plat 3, will give the increase due to the fertilizer. The increase of plat 2, is obtained by subtracting the result obtained by dividing the sum of the yields of plat 1, and the estimated yield of plat 3 without fertilizer, by two. The increase of plat 4 is obtained in the same manner, by using the yield of plat 5, and the estimate of plat 3.

Value of Cotton Seed Meal per ton, estimated.....$20.00.
Value of Acid Phosphate per ton, estimated..... 20.00.
Value of Kainit per ton, estimated ..... 10.00.
Value of Seed Cotton ..... 2½c. per lb.

In calculating profit from the use of fertilizers, the cost of labor in handling and applying the fertilizer is not considered. Twenty-five cents an acre will cover the cost of applying with an ordinary cotton planter.

CONCLUSIONS.

I. Cotton Seed Meal increases the yield, and can be used with profit.

II. Neither Acid Phosphate, nor Kainit give any appriciable increase in the yield, and can not be used with profit.

SET II.

Object: To test the effect of combining the different fertilizers.

Similiar in soil, arrangement, and time of planting to Set I.

	POUNDS SEED COTTON PER ACRE.	INCREASE PER ACRE.	VALUE OF INCREASE.	COST OF FERTILIZER.	PROFIT FROM USE OF FERTILIZER.	LOSS FROM USE OF FERTILIZER.
Plat 5, Blank	1110					
" 6, 300 lbs. Csm 300 lbs. Acid Phosphate	1380	270	$6 75	$6 00	$ 75	
" 7, 300 lbs. " 300 lbs. Acid Phosphate 350 lbs. Kainit	1275	165	4 12	7 75		$3 63
" 8, 150 lbs. Csm. 180 lbs. Acid Phosphate 350 lbs. Kainit	1170	60	1 50	5 05		3 55
" 9, 300 lbs Csm. 350 lbs. Kainit	1290	180	4 50	4 75		25
" 10, Blank	945					

The fertilized plats in these experiments are compared with blank No. 5. There is a decrease in fertility from No. 5 to No. 10. This being true, the profits from the use of fertilizers would be somewhat larger than the estimated profits, and the losses correspondingly smaller.

CONCLUSIONS.

I. Since Cotton Seed Meal is the only fertilizer that gives any perceptible increase when used alone, it is reasonable to suppose that it is this fertilizer, that the increase in yield in these experiments is due.

II. That the use of Acid Phosphate and Kainit in combinations with Cotton Seed Meal, increase the cost of the fertilizer, without any corresponding increase in the yield.

SET III.

Object: To compare the effects of Stable and Barnyard Manure.

	POUNDS SEED COTTON PER ACRE.	INCREASE PER ACRE.	VALUE OF INCREASE.	COST OF FERTILIZER.	PROFIT FROM USE OF FERTILIZERS.	LOSS FROM USE OF FERTILIZER.
Plat 10, Blank..	945					
" 11, Fifteen one-horse loads stable manure	1185	240	$6 00	$1 00	$5 00	
" 12, Thirty one-horse loads stable manure	1470	530	13 25	2 00	11 25	
" 13, Thirty one-horse loads barnyard manure	1215	270	6 75	1 00	5 75	
" 14, Sixty one-horse loads barnyard manure	1590	645	16 12	2 00	14 12	
" Blank	900					

It must be remembered that the cost of labor is not deducted from the value of the increase in estimating profits.

EXPERIMENTS WITH COMPOSTS.

SET. IV.

Object: To compare the effects of different composts.
Similar soil and time of planting to preceding sets.
Six rows equal to 1-10 acre, used for each experiment.

	POUNDS SEED COTTON PER ACRE.	INCREASE PER ACRE.	VALUE OF INCREASE.	COST OF FERTILIZER.	PROFIT FROM USE OF FERTILIZER.	LOSS FROM USE OF FERTILIZER.
Plat 1, 1600 lbs. Georgia and Alabama Compost, 400 lbs. Sup. 600 lbs. cotton seed, 600 lbs. Stable manure	1170	75	$1 87	$7 60		$5 73
Plat 2, 1600 lbs. Furman's Compost, 266⅔ Sup. 133⅓ lbs. K., 600 lbs. Stable manure, 600 lbs. C. S	1125	30	75	6 93		6 18
Plat 3, 1600 N. C. Compost, 640 Sup. 160 K. 480 C. S. 320 Stable manure	1140	45	1 12	9 92		8 80
Plat 4, 1600 lbs. S. C. Compost, 600 lbs. Sup. 280 lbs. K. 480 C. S. 240 lbs Stable manure	1170	75	1 87	10 04		8 17
Plat 5, 1600 lbs. S. C. Com. No. 6 600 Floats 280 K. 240 lbs. Stable manure 480 C. S	1200	105	2 62	10 04		7 42
Plat 6, Blank	1095					
Plat 7, 1600 lbs. S. C. Com., No. 7, 600 Sup. 280 K. 720 C. S	1207	112	2 80	11 00		8 20
Plat 8, 1600 lbs. S. C. Com., No. 8, 600 Floats 280 K. 720 C. S	1260	165	4 12	11 00		6 88
Plat 9, 1600 lbs Cotton seed	1350	255	6 37	8 00		1 63
Plat 10, 1600 lbs. S. C. Com., No. 5, 800 C. S. 800 Stable manure	1350	255	6 37	4 80	$1 57	

The composts for these experiments were made in the open air and covered with boards to prevent leaking. They were made the first week in March, and allowed to remain in the heap until the second week in April.

It is not difficult to draw conclusions from these experiments; they go to sustain those already deduced from sets 1 and 2, that only nitrogenous manures can be used with profit on the worn lands of the bottoms.

The failure of cotton seed to do better was probably due to their late application. Crops do not get the full benefit of cotton seed the first year, and as a rule the later the seed are killed and applied, the smaller will be the benfit derived during the first season.

EXPERIMENTS ON THE ECONOMIC VALUE OF FERTILIZERS.

SET. V.

Object: a. To ascertain what quantities of fertilizers, per acre, will give the largest per cent. of profit.

b. To compare the effects of mixtures 1 and 2.

Mixture No. 1. Six parts of Cotton Seed Meal and two parts Acid Phosphate.

Mixture No. 2. Six parts of Cotton Seed Meal, two parts Acid Phosphate and one part Kainit.

Soil. Thin, sandy bottom.

Similar arrangement and time of planting to sets I and II.

	POUNDS SEED COTTON PER ACRE.	INCREASE PER ACRE.	VALUE OF INCREASE.	COST OF FERTILIZER.	PROFIT FROM USE OF FERTILIZER.	LOSS FROM USE OF FERTILIZER.
Plat 1, Blank	675	.....	$.....	$.....	$.....	$ .....
Plat 2, 300 lbs. mixture No. 1, 225 cotton seed meal, 75 lbs. Acid Phosphate	810	135	3 37	3 00	37	.....
Plat 3, 337½ lbs. mixture No. 2, 225 lbs. cotton seed meal, 75lbs. Acid Phosphate, 37½ lbs Kainit	930	255	6 37	3 18	3 19	.....
Plat 4, 400 lbs. mixture No. 1, 300 lbs. cotton seed meal, 100 lbs. Acid Phosphate	945	270	6 75	4 00	2 75	.....
Plat 5, 450 lbs. mixture No. 2, 300 lbs. cotton seed meal, 100 lbs. Acid Phosphate, 50 lbs. Kainit	960	285	7 12	4 25	2 87	.....
Plat 6, 500 lbs. mixture No. 1, 375 lbs. cotton seed meal, 125 lbs. Acid Phosphate	900	225	5 62	5 00	62	.....
Plat 7, 562½ lbs. mixture No. 2, 375 lbs. cotton seed meal, 125 lbs. Acid Phosphate, 62½ lbs. Kainit	975	300	7 50	5 31	2 19	.....
Plat 8, Blank	705	.....	.....	.....	.....	.....
Plat 9, 700 lbs. mixture No. 1, 524.7 lbs. cotton seed meal, 175.3 lbs. Acid Phosphate	1260	555	13 87	7 00	6 87	.....
Plat 10, 787.45 lbs. mixture No. 2, 524.7 lbs. cotton seed meal, 175.3 lbs. Acid Phosphate, 87.45 lbs. Kainit	1230	525	13 12	7 43	5 69	.....
Plat 11, 900 lbs. mixture No. 1, 675 lbs. cotton seed meal, 225 lbs. Acid Phosphate,	1395	690	17 25	9 00	8 25	.....
Plat 12, 1012 lbs. mixture No. 2, 675 lbs. cotton seed meal, 225 lbs. Acid Phosphate, 112 lbs. Kainit	1590	885	22 12	9 56	12 56	.....
Plat 13, Blank	960	.....	.....	.....	.....	.....

There is an increase in fertility from blank 8 to blank 13. This would cause the estimated profits on the fertilizer plats, since they are compared with blanks to be larger than they really are, the variation from the true profit increasing as blank 13 is approached.

If these experiments were to be accepted as decisive, the conclusion would be reached that the per cent. of profit varies very slightly with the quantities of fertilizers used. But no definite conclusions can be drawn from these experiments. The season was an unusually wet one, and consequently very favorable to the use of large quantities of fertilizers. Had the season been a dry one, the result would probably have been very different. The general rule in regard to the quantity of fertilizer to be used, is that small quantities varying between 200 and 500 pounds are safe, and will give a large per cent. of profit on the cost.

VARIETIES OF COTTON.

Object: To test the yield of seed cotton of different varieties.

The rows in these experiments were run nearly at right angles across a slight depression. In this manner a nearly uniform fertility was received for all plats.

Six rows, equal to 1-10 acre, were used for each variety.

	PER CENT. PICKED OCTOBER 10th.	PER CENT. PICKED SEPTEMBER 24th.	POUNDS SEED COTTON.
Queen	69.03	32.9	775
Southern Hope	71.9	31.	645
Ozier Silk	66.2	21.4	770
Moon	64.4	25.2	915
Peterkin	62.4	24.8	905
Crawford	63.4	24.8	985
Hawkins	65.6	29.5	845
Peerless	64.7	27.9	965

The yield of the Jeff Welborn Pet cotton is not given because the stand was destroyed by heavy rains in June. It is a cluster cotton of a very pronounced type, many of the stalks not having any limbs. Its strong point is its habit of ma

turing early. By September 24th 39.1 per cent. of the entire yield had been gathered, and by October 10th 79.3 per cent. This places it 6.2 per cent. ahead of any other variety at the first date, and 7.4 per cent ahead at the second. No conclusion can be formed as to what the yield would have been if the stand had not been destroyed. If should be remembered, in noting the per cents of cotton picked at the dates given, that the variety tests were not fertilized, and that they were planted ten days later than the cotton for the fertilizer tests.

All of the experiments conducted at this station with fertilisers go to show that nitrogenous manures will greatly increase the yield of cotton on our worn lands; but this increase in yield is not the only benefit derived. Maturity is hastened, and the planter enabled to gather a larger per cent. of his cotton while the weather is warm and favorable for picking.

The following tables show the per cent. of cotton that had been picked from each plat in sets I., II., III. and V. at the dates named.

TABLE I.

	PER CENT. PICKED SEPTEMBER 19th.	PER CENT. PICKED OCTOBER 7th.
Plat 1, Blank	38.4	84.6
Plat 2, 300 lbs. cotton seed meal	43.	79.7
Plat 3, 350 lbs. Acid Phosphate	35.8	71.6
Plat 4, 350 lbs. Kainit	30.3	69.6
Plat 5, Blank	37.8	78.4
Plat 6, 300 lbs. cotton seed meal, 300 lbs. Acid Phosphate	44.7	78.2
Plat 7, 300 lbs. cotton seed meal, 300 lbs. Acid Phosphate, 350 lbs. Kainit	44.7	81.1
Plat 8, 150 lbs. cotton seed meal, 180 lbs. Acid Phosphate, 350 lbs. Kainit	43.5	78.2
Plat 9, 300 lbs. cotton seed meal, 350 lbs. Kainit	39.5	78.4
Plat 10, Blank	38.	77.7
Plat 11, fifteen one-horse loads stable manure	48.1	82.3
Plat 12, thirty one-horse loads stable manure	53.	84.6
Plat 13, thirty one-horse loads barn yard manure	44.4	80.2
Plat 14, sixty one-horse loads barnyard manure	44.3	84.7
Average per cent. picked on the three blanks, 1, 5 and 10	38.	80.2
Average per cent. picked on the plats, 2, 6, 7, 8 and 9, to which cotton seed meal was applied, either alone or in combination	43.08	79.1
Average per cent. picked on stable manure plots	50.5	83.4
Average per cent. picked on barnyard manure plots	44.35	84.7

TABLE II.

	PER CENT. PICKED SEPTEMBER 20th.	PER CENT. PICKED OCTOBER 8th.
Plat 1, blank	33.	77.7
Plat 2, 225 lbs. cotton seed meal, 75 lbs. Acid Phosphate	42.5	81.3
Plat 3, 225 lbs. cotton seed meal, 75 lbs. Acid Phosphate, 37½ lbs. Kainit.	38.7	80.6
Plat 4, 300 lbs. cotton seed meal, 100 lbs. Acid Phosphate	47.	84.1
Plat 5, 300 lbs. cotton seed meal, 100 lbs. Acid Phosphate, 50 lbs. Kainit	42.	82.8
Plat 6, 375 lbs. cotton seed meal, 125 lbs. Acid Phosphate	40.	78.3
Plat 7, 375 lbs. cotton seed meal, 125 lbs. Acid Phosphate, 62½ lbs. Kainit	46.1	81.5
Plat 8, blank	34.	77.3
Plat 9, 524.7 lbs. cotton seed meal, 175.3 lbs Acid Phosphate	46.4	80.9
Plat 10, 524.7 lbs. cotton seed meal, 175.3 lbs. Acid Phosphate, 87.45 lbs. Kainit	39.	75.1
Plat 11, 675 lbs. cotton seed meal, 225 lbs Acid Phosphate,	40.8	81.7
Plat 12, 675 lbs. cotton seed meal, 112 lbs. Kainit, 225 lbs Acid Phosphate	39.6	79.1
Plat 13, blank	37.6	75.
Average per cent. picked on the three blanks	34.9	75.
Average per cent. picked on plats, 2, 4, 6, 9 and 11	43.3	81.2
Average per cent. picked on plats, 3, 5, 7, 10 and 12	41.08	79.8

It will be noted from these tables, that neither Acid Phosphate nor Kainit, when used singly, hastens the maturity of cotton, and that cotton seed meal, when used alone, hastens maturity nearly five per cent. In table I. the average of all plats on which cotton seed meal was used, either singly or in combination, is five per cent higher than that of the three blanks. In table II. the average of the cotton seed meal and phosphate plats is 8.4 per cent. higher than that of the three blanks, and nearly two per cent. higher than that of the cotton seed meal, acid phosphate and kainit plats. These facts point to the following conclusions:

1. That nitrogenous manures hastens the maturity of cotton.

2. That nearly the full benefit of this hastening of maturity is obtained by September 20th.

3. That the use of kainit retards the opening of cotton.

SYSTEM OF CULTIVATION.

Thorough preparation and shallow, level cultivation, is the system that has been adopted at this station. The preparation and cultivation for the past year was substantially as follows: The land was first broken broadcast and then harrowed. The rows were then laid off the desired width, the fertilizers applied in the furrow, and the land bedded. Just before planting, an ordinary tooth harrow was dragged across the rows at right

angles. This carries all of the trash and clods into the middles, and leaves the beds in excellent condition for planting. If the beds have been packed by rains since bedding, this harrowing is doubly desirable, for it not only drags the trash and clods into the middles, but freshens up the beds and puts them in better condition for the reception of the seed.

The planting was done with a Banner planter; about one bushel of seed being used to the acre. As soon as the cotton was up, it was sided with a harrow. All subsequent cultivation, except one plowing, was done with heel sweeps. Heavy rains in June packed the soil and rendered necessary, a deep plowing with a fourteen inch solid sweep. In this case the deep plowing was resorted to as the lesser of two evils.

The roots of the cotton plant are frequently four or five feet long, and take up every available inch of soil. It is through its roots that the plant gets its food, and it is obvious, that whenever these roots are destroyed, the food supply is cut off, and the growth of the plant correspondingly checked. Whenever deep cultivation is practiced, the growth of the plant is continually checked, and its full development retarded. The general effect of deep cultivation is to delay the growth of the plant, and it should not be resorted to unless heavy rains have packed the soil; and then, only as the lesser of two necessary evils.

Shallow cultivation is more economic than deep. Two furrows with a twenty-two, or twenty-six inch heel sweep, will clean the row, and leave so small a middle, that it is unnecessary to throw it out. This saving of the third furrow will very materially reduce the cost of cultivation.

WHY CULTIVATION SHOULD BE LEVEL.

The evaporation of moisture from an acre of land, other things being equal, depends on the area of surface exposed. An acre of land thrown up into ridges would have a much larger exposed surface, than an acre of land which was perfectly level. This being true, it will follow, that the nearer level the surface of the land, the greater will be the quantity of moisture retained, and the greater the length of time that it can be ex-

pected to withstand drouth. Level culture is not laid down as a fixed rule. Ridge culture may sometimes be necessary where the land is cold and poorly drained. But if the land is naturally well drained, there is no reason why the ridges, which have been thrown up in the spring to secure warmth, should be restored after they have been leveled down by the first working.

The advantages of shallow and level cultivation may be briefly stated as follows:

I. Shallow cultivation destroys the least possible number of roots, and permits the plant to mature earlier.

II. Shallow cultivation requires less labor and is more economic than deep.

III. Level cultivation retains moisture, and enables the land to better withstand drouth.

SOURCES OF ERROR IN EXPERIMENTS.

In all experiments with field crops and vegetables there are sources of error that must be recognized and guarded against by the careful experimentalist. In order to give assurance that these sources of error have been fully taken into consideration, and guarded against as far as possible, it is deemed advisable to briefly notice the more important sources.

I. Inequality in the fertility of the soil. This source of error has been partially overcome in the fertilizing experiments, by leaving frequent blank plats; and in the variety tests by running the rows at right angles across the richer depressions.

II. Inequality in the stand. This is a very important source and cannot be entirely overcome except by checking, and thinning to an equal number of stalks in each hill, It has been partially avoided, by having all thinning done by a few careful hands.

III. Length of time elapsing between the working of the first plat of a set of experiments, and the last. This source of error is not appreciable unless plowing or hoeing is interrupted by a rain.

IV. In fertilizing experiments in which the plats are small, there is another source of error. Suppose we have eighteen

rows three and a half feet wide by seventy yards long. Fertilize the middle six with cotton seed meal, leaving six rows on either side without fertilizer. Since the roots of the cotton plant are frequently five feet long, it is obvious that the rows, adjoining the six fertilized rows, will be benefited to some extent by the fertilizer, while the yield of the six fertilized rows will be diminished in proportion. This source of error has been guarded against by taking the yield of the four inside, and the two outside rows of each plat separately. By taking the yields of the plats in this way, the outside row of the four on which the yield is computed, is seven feet distant from the outside row of the adjoining plat, and ten and one-half feet distant from the nearest of the four rows on which the yield is computed.

In conclusion we give a brief summary of the facts that have been brought out by the experiments with fertilizers.

1st. Nitrogenous manures can be used with profit on our worn lands at Pine Bluff.

2nd. One of the effects of nitrogenous manure is to hasten maturity.

3rd. Neither Acid Phosphate, nor Kainit can be used with profit here.

4th. All of the fifteen different plats on which cotton seed meal was used, either alone or in combination, gave some profit, and that this profit was due, not to the Acid Phosphate and Kainit, but to the cotton seed meal.

5th. There is no better fertilizer than stable and barn yard manure.

SORGHUM.

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The investigation of sorghum as a sugar producing plant, have been continued. The results, have by no means been conclusive, and it will take some years to work out the problem. Two factors operate against the successful production of sugar from sorghum. One is the enormous first cost of the plant necessary to manufacture the sugar, which at present is not much less than $100,000. The other is the low and variable per centage of sucrose in the cane. It is to be hoped that ingenuity, and enterprise will reduce the first cost, so that the business will give returns on money invested.

The aim of our experiments is to find the varieties rich in sucrose, which are adapted to our climate, then by fertilization, and selection, to increase the amount of sucrose. It is a fact that the seed from canes, rich in sucrose, will produce other canes of like richness. Individual canes differ so widely in per centage of sucrose, that each cane must be tested. The juice from many canes was expressed, and the amount of total solids determined by Brix spindle. The seeds from the canes having the largest per centage of sucrose are reserved. This selected lot when grown is subjected to analysis, and the seed from those canes which contained the largest per centage of sucrose is again saved for planting. In this way in the course of a few years it is expected that we can produce seed which will uniformly grow canes containing a high per centage of sucrose.

VARIETY.	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CT. SOLIDS BY BRIX.	SPECIFIC GRAVITY.
No. 43	Aug. 17	76	40	10.0	25	5.75	1.15	8.0	1.058
"	Aug. 26	134	68	19.8	29	3.14	0.59	9.0	1.039
"	Sept. 3	130	67	16.0	24	2.92	0.29	9.4	1.038
No. 58	Aug. 15	72	41	9.3	23	4.50	2.17	10.8	1.051
"	Aug. 17	108	57	11.3	20	3.46	0.64	7.6	1.058
"	Aug. 26	145	76	21.4	28	2.98	0.76	8.8	1.035
"	Sept. 3	142	77	19.0	25	2.29	0.37	8.6	1.035
No. 30	Aug. 26	145	80	26.8	34	5.34	0.32	8.4	1.034
"	Sept. 4	159	100	28.7	29	5.97	0.66	12.6	1.049
No. 27	Aug. 17	100	56	19.0	34	7.51	1.03	11.9	1.058
"	Aug. 26	143	70	21.8	31	4.84	0.74	10.8	1.043
"	Sept. 4	136	76	25.0	33	6.66	1.47	12.2	1.049
No. 42	Aug. 15	76	44	9.0	21	5.82	2.91	11.9	1.058
"	Aug. 26	192	108	31.5	29	5.03	0.63	11.0	1.045
"	Sept. 4	181	101	27.7	27	5.15	0.97	12.0	1.049
No. 1	Aug. 17	98	50	10.7	22	3.60	0.85	10.7	1.062
"	Aug. 21	82	45	22.5	50	7.76	2.60	13.8	1.052
"	Sept. 4	183	101	52.0	52	6.54	0.99	11.4	1.045
"	Sept. 19	156	96	42.4	45	3.96	0.87	11.0	1.045
No. 5	Aug. 15	58	28	5.0	18	4.25	2.45	10.7	1.048
"	Aug. 26	122	58	14.3	25	2.57	0.64	8.7	1.034
"	Sept. 4	177	93	41.5	45	7.54	2.17	12.6	1.051
No. 18	Aug. 15	64	38	7.6	20	4.59	2.11	10.5	1.052
"	Aug. 17	102	53	10.6	20	2.45	0.53	8.2	1.047
"	Aug. 26	146	76	22.1	29	3.14	0.44	9.2	1.037
"	Sept. 4	216	114	25.1	22	3.99	0.44	10.4	1.043
Hybrid No. 18	Aug. 16	90	68	37.5	55	9.52	3.04	13.3	1.054
" "	Sept. 4	118	88	56.1	64	9.43	5.49	15.4	1.064
Red Kaffir	Sept. 4	142	82	41.0	50	3.70	0.87	10.2	1.041
"	Sept. 10	90	75	41.0	55	4.40	0.63	8.8	1.037
"	Sept. 19	114	72	37.5	53	2.61	0.62	7.6	1.033
"	Sept. 27	112	70	28.0	40	4.40	0.56	13.4	1.041
Link's Hybrid	Aug. 21	90	68	34.8	51	12.95	2.55	16.4	1.067
"	Sept. 4	153	108	56.7	53	11.53	1.33	14.8	1.060
"	Sept. 10	140	84	36.9	44	10.37	1.30	13.6	1.057
"	Sept. 19	103	74	30.8	42	10.94	1.21	15.0	1.060
"	Sept. 27	65	50	27.0	54	14.24	0.81	18.4	1.074
Red Liberian	Sept. 4	146	109	41.7	38	12.10	1.49	15.8	1.064
"	Sept. 10	120	96	39.0	41	12.32	1.36	16.0	1.063
"	Sept. 20	85	66	25.3	38	9.74	4.03	15.4	1.061
"	Sept. 27	63	50	24.0	48	11.69	3.75	17.2	1.068
Hybrid, No. 15	Aug. 21	96	65	40.1	62	13.33	2.64	16.2	1.067
" "	Sept. 4	100	68	37.4	55	12.57	2.54	15.8	1.065
" "	Sept. 20	100	74	34.9	47	11.16	3.02	16.4	1.064
" "	Sept. 27	76	61	26.5	43	16.03	1.86	20.2	1.081
" 9	Aug. 21	83	58	29.5	51	10.21	1.50	14.0	1.058
" "	Sept. 4	111	78	34.0	44	10.37	2.05	14.4	1.060
" "	Sept. 20	112	78	41.5	53	10.72	0.81	15.0	1.059

VARIETY.	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Hybrid No. 9	Sept. 27	83	66	28.4	43	13.31	1.35	15.4	1.062
White Mammoth	Aug. 16	87	63	34.4	55	9.74	3.94	13.2	1.053
"	Aug. 21	83	60	33.3	55	10.06	3.82	15.3	1.057
"	Sept. 4	110	88	46.1	53	11.63	1.89	15.4	1.063
"	Sept. 20	112	89	49.4	55	12.22	1.67	16.6	1.066
"	Sept. 27	101	86	40.3	47	13.83	1.58	17.2	1.071
No. 36 from S. A	Aug. 20	70	53	25.7	48	8.45	3.02	13.2	1.053
" " "	Aug. 23	44	28	11.0	39	9.31	2.91	14.2	1.058
" " "	Sept. 3	100	68	24.8	34	7.00	2.07	12.0	1.044
" " "	Sept. 10	96	66	24.8	37	5.66	2.23	10.0	1.041
" " "	Sept. 19	104	76	34.9	46	4.08	2.26	10.2	1.041
" " "	Sept. 26	60	48	18.5	39	15.90	0.77	19.6	1.080
No. 24 " "	Aug. 20	54	32	13.4	42	8.39	3.31	13.4	1.054
" " "	Aug. 23	80	62	33.6	54	11.63	3.25	15.2	1.062
" " "	Sept. 3	148	105	59.0	56	8.86	4.55	13.8	1.057
" " "	Sept. 10	156	102	59.4	58	7.64	3.19	12.0	1.047
" " "	Sept. 19	118	82	42.0	51	7.95	3.62	13.6	1.051
No. 39 " "	Aug. 20	66	50	27.0	54	11.47	3.23	15.0	1.060
" " "	Sept. 3	105	80	45.1	56	11.75	2.67	15.2	1.061
" " "	Sept. 9	144	115	58.5	51	13.04	3.35	16.4	1.067
" " "	Sept. 18	126	91	40.8	45	14.14	0.59	18.6	1.073
Folger's Early	Aug. 20	62	76	31.5	41	13.60	3.48	17.3	1.070
"	Aug. 23	69	57	27.4	48	12.57	3.57	16.6	1.067
"	Aug. 23	89	70	37.4	53	12.67	3.70	16.2	1.068
"	Sept. 3	124	84	42.0	50	12.16	2.42	15.4	1.063
"	Sept. 18	84	68	39.4	58	9.21	3.16	13.8	1.056
Prices New Hybrid	Aug. 23	106	76	32.0	42	12.48	3.59	16.6	1.068
" " "	Aug. 23	66	48	22.0	46	9.48	3.63	14.2	1.059
" " "	Sept. 9	118	82	42.6	53	10.53	1.43	14.2	1.059
No. 53 from So. Africa	Aug. 23	110	81	46.4	57	12.26	2.79	16.2	1.065
" " "	Sept. 9	90	64	26.0	41	10.40	1.74	14.4	1.058
" " "	Sept. 19	120	94	51.6	55	6.91	4.40	12.2	1.050
" " "	Sept. 26	85	66	18.8	29	8.49	4.14	14.0	1.056
O	Sept. 9	142	100	64.4	54	11.56	1.18	14.8	1.066
O	Sept. 19	116	84	35.5	43	11.44	2.91	15.6	1.062
O	Sept. 27	74	54	19.8	36	14.14	2.82	17.4	1.071
E	Aug. 21	82	52	16.8	32	8.33	3.82	15.4	1.062
E	Sept. 3	140	95	57.0	54	10.81	2.17	14.8	1.061
E	Sept. 18	130	92	46.5	50	10.84	2.14	15.0	1.059
E	Sept. 26	74	51	16.8	32	11.34	1.38	16.0	1.065
No. 57	Aug. 20	72	54	25.1	46	6.63	5.61	12.8	1.060
"	Sept. 3	117	78	43.0	55	7.76	3.79	12.6	1.051
"	Sept. 10	156	101	55.5	55	5.88	3.60	11.0	1.045
"	Sept. 19	104	72	35.8	50	9.14	3.81	14.4	1.050
"	Sept. 26	72	56	29.3	52	12.91	3.22	16.6	1.070
Waubausee	Aug. 20	64	50	26.1	53	10.53	2.32	14.0	1.056
"	Aug. 23	66	50	27.3	55	8.99	2.23	13.0	1.053
"	Sept. 3	114	82	40.9	50	9.27	2.29	13.0	1.052
"	Sept. 10	102	80	56.9	71	7.63	1.36	16.0	1.046

VARIETY.	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Waubausee	Sept. 19	102	78	35.0	46	9.05	2.15	13.4	1.053
"	Sept. 26	74	53	24.9	47	9.90	1.64	13.6	1.057
Chinese	Aug. 20	68	47	17.4	38	9.33	3.44	14.4	1.059
"	Aug. 23	84	60	38.0	63	11.06	2.98	15.2	1.060
"	Sept. 3	126	84	43.5	51	10.37	2.27	14.2	1.057
"	Sept. 10	102	68	34.1	50	8.80	2.34	12.8	1.052
"	Sept. 19	122	100	51.9	52	8.30	2.60	13.0	1.053
"	Sept. 26	50	33	5.5	17	11.31	0.70	17.6	1.067
Central American	Aug. 21	82	62	32.8	55	6.82	5.34	12.2	1.050
"	Aug. 23	73	50	29.5	59	8.86	2.96	13.2	1.051
"	Sept. 3	100	73	39.6	50	9.11	3.41	13.0	1.052
"	Sept. 10	78	60	28.8	48	9.90	3.16	13.8	1.058
"	Sept. 19	88	68	34.8	51	9.49	2.79	14.0	1.057
"	Sept. 26	55	43	18.9	44	11.25	2.32	15.6	1.063
Honey Dew	Sept. 19	112	77	41.1	54	12.82	2.60	17.0	1.069
Whitney's Early	Aug. 20	78	58	31.7	55	10.83	2.98	14.4	1.058
"	Aug. 23	86	66	29.8	45	13.00	2.36	16.4	1.068
"	Sept. 3	133	88	52.4	58	8.80	3.26	13.0	1.054
"	Sept. 10	148	96	43.8	46	7.64	2.88	11.6	1.046
Swain's Early Golden	Aug. 20	82	60	44.7	74	11.53	2.24	15.0	1.062
" " "	Aug. 23	78	54	29.3	54	11.44	3.01	15.4	1.063
" " "	Sept. 3	106	84	47.5	56	11.75	1.98	14.6	1.061
" " "	Sept. 10	124	96	59.5	62	9.81	2.11	13.0	1.053
" " "	Sept. 19	86	66	36.5	55	10.43	2.06	14.4	1.058
White African	Aug. 21	95	68	37.5	55	8.58	3.39	13.0	1.051
" "	Sept. 3	140	94	46.5	53	11.31	1.44	14.8	1.061
" "	Sept. 10	144	96	51.5	53	9.90	1.05	13.6	1.056
" "	Sept. 19	134	94	41.0	44	11.00	1.52	16.0	1.062
" "	Sept. 26	74	55	22.0	40	13.83	1.80	16.6	1.073
Improved Orange	Aug. 21	78	58	29.6	51	9.68	4.20	13.8	1.051
" "	Sept. 3	124	84	44.7	48	11.31	2.11	15.2	1.059
" "	Sept. 10	90	75	48.8	65	9.59	4.59	14.4	1.059
" "	Sept. 26	81	57	24.6	43	13.86	2.42	16.8	1.070
Seg	Aug. 21	86	58	26.1	45	10.59	2.91	14.8	1.060
"	Sept. 3	150	130	74	57	12.73	1.53	16.0	1.064
"	Sept. 9	108	88	52.5	60	11.81	1.24	15.0	1.060
"	Sept. 19	106	86	40.3	47	11.88	1.36	15.8	1.063
Early Orange	Sept. 2	102	68	34.1	50	11.16	2.91	14.4	1.059
" "	Sept. 20	84	64	34.0	53	8.64	2.70	12.2	1.049
" "	Sept. 20	64	44	19.0	43	12.38	2.36	16.2	1.063
" "	Sept. 27	50	40	18.3	46	14.08	2.40	18.0	1.072

EFFECT OF FERTILIZATION ON THE COMPOSITION OF SORGHUM CANE.

In this experiment, an acre was divided into forty equal plats, and treated with various fertilizers; at maturity the cane was analyzed to note the effect. The variety selected was

Early Orange, and seed was planted on all the plats. However a volunteer crop of Early Amber appeared on plats 13 to 42 inclusive, which at maturity could be easily distinguished, and was carefully separated and analyzed. We have thus parallel results on two varieties of cane. The results are by no means conclusive, and further investigation in this line will be needed.

EARLY ORANGE.

	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT OF GLUCLOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Plat 1.	Aug. 28	91	76	36.4	48	13.01	2.39	17.2	1.068
16¼ lbs. Cotton Seed Meal	Sept. 4	127	90	41.4	46	13.04	1.67	16.0	1.067
	Sept. 16	112	84	41.9	50	11.47	0.97	15.2	1.060
	Sept. 20	102	83	46.0	55	13.69	1.74	17.6	1.071
Plat 2.	Aug. 28	112	88	46.3	52	13.51	2.26	17.3	1.070
7½ Cotton Seed Meal..	Sept. 4	126	93	50.3	54	12.26	1.98	15.7	1.065
11¼ Acid Phosphate....	Sept. 16	122	80	43.3	54	12.10	1.52	15.6	1.062
	Sept. 20	80	62	25.0	40	12.73	1.64	16.4	1.067
Plat 3.	Aug. 28	90	68	33.9	50	13.83	2.79	17.4	1.072
9⅜ Cotton Seed Meal..	Sept. 4	112	81	43.0	55	13.20	1.86	16.4	1.067
9⅜ Acid Phosphate.....	Sept. 16	136	96	53.6	45	12.10	1.16	15.4	1.061
	Sept. 20	90	72	35.0	49	11.19	2.89	15.2	1.062
Plat 4.	Aug. 28	72	54	26.4	49	12.66	2.74	16.2	1.067
12¼ Cotton Seed Meal	Sept. 5	110	83	45.7	53	12.26	2.08	15.6	1.063
6⅛ Acid Phosphate....	Sept. 16	104	72	38.8	54	12.27	1.07	15.6	1.063
	Sept. 20	108	69	30.5	44	10.62	1.77	17.6	1.069
Plat 5.	Aug. 28	67	50	26.8	54	12.75	2.52	16.3	1.065
15 lbs. Cotton Seed Meal.....	Sept. 5	120	91	47.9	54	12.26	1.40	15.7	1.065
	Sept. 16	96	68	34.6	51	10.37	1.23	14.0	1.056
3¾ lbs. Acid Phosphate	Sept. 20	95	74	33.0	45	12.91	1.33	16.6	1.068
Plat 6.	Aug. 28	80	58	26.4	46	14.24	1.98	18.0	1.073
16¼ lbs. Cotton Seed Meal	Sept. 5	100	76	41.3	53	12.26	1.24	16.0	1.065
	Sept. 16	128	88	42.0	48	9.90	1.67	13.4	1.054
2½ lbs. Acid Phosphate	Sept. 20	78	60	25.8	43	13.80	1.58	17.4	1.069
Plat 7.	Aug. 28	80	62	30.4	49	14.61	2.05	18.0	1.071
8¾ Cotton Seed Meal	Sept. 5	111	82	43.9	52	13.83	1.64	17.0	1.069
12½ Acid Phosphate..	Sept. 16	96	64	37.3	59	9.75	1.27	13.4	1.054
2 lbs. Kainit.....	Sept. 20	88	70	32.3	46	14.36	1.52	18.0	1.074
Plat 8.	Aug. 28	92	68	35.9	52	13.20	2.39	16.6	1.068
2½ lbs. Acid Phosphate	Sept. 5	110	88	45.9	52	13.36	1.30	16.6	1.066
	Sept. 16	104	80	41.1	51	11.63	1.42	15.0	1.061
	Sept. 20	74	60	29.5	49	13.45	1.80	17.4	1.069

EARLY ORANGE.

	DATE.	WEIGHT OF UNSTRIPPED. OUNCES.	WEIGHT OF STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER. CENT. OF GLUCOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Plat 9.	Aug. 28	97	76	37.0	49	13.83	2.29	17.4	1.072
5 lbs. Acid Phosphate	Sept. 5	82	60	29.7	50	10.53	1.86	14.4	1.059
	Sept. 16	112	80	44.0	55	11.47	1.73	15.0	1.061
Plat 10.	Aug. 28	100	72	39.0	54	11.88	3.42	15.6	1.064
7½ lbs. Acid Phosphate	Sept. 5	89	66	35.5	54	10.84	1.14	14.4	1.060
	Sept. 16	104	72	37.8	53	9.74	1.24	13.2	1.054
Plat 11.	Aug. 29	76	58	29.6	51	12.26	2.63	16.0	1.064
10 lbs. Acid Phosphate	Sept. 5	102	72	35.6	49	11.63	2.34	15.3	1.062
	Sept. 16	120	88	50.0	57	9.96	1.24	13.6	1.060
Plat 12.	Aug. 29	90	68	33.3	49	13.36	2.32	17.0	1.070
12½ lbs. Acid Phosp'te	Sept. 5	102	84	38.7	46	10.84	2.45	14.6	1.059
	Sept. 16	128	96	50.0	52	11.94	1.33	15.0	1.053
Plat 13.	Sept. 2	120	90	39.0	44	10.21	3.66	16.0	1.058
15 lbs. Acid Phosphate	Sept. 9	136	94	52.5	56	10.50	1.77	13.8	1.057
	Sept. 18	85	66	31.0	47	14.14	1.61	17.8	1.072
	Sept. 25	82	70	31.5	45	15.56	0.99	19.0	1.079
Plat 14.	Sept. 2	160	73	39.1	54	13.10	1.39	16.0	1.063
2½ lbs. Dried Blood....	Sept. 9	112	78	37.6	48	12.88	1.43	16.0	1.065
	Sept. 18	113	70	33.0	47	13.64	1.47	16.6	1.069
	Sept. 25	76	56	25.3	45	13.20	1.62	17.2	1.069
Plat 15.	Sept. 2	104	70	35.9	51	12.91	1.08	15.2	1.065
5 lbs. Dried Blood.....	Sept. 9	208	148	73.6	50	11.16	0.90	15.8	1.061
	Sept. 18	94	66	35.3	54	13.33	1.24	17.0	1.069
	Sept. 25	52	40	17.8	44	14.46	1.83	17.4	1.073
Plat 16.	Sept. 2	104	76	39.6	52	13.20	1.18	15.2	1.066
7½ lbs. Dried Blood	Sept. 9	124	88	45.0	51	12.10	2.98	15.4	1.063
	Sept. 18	92	84	45.0	54	12.10	1.42	15.8	1.063
	Sept. 25	64	48	24.3	51	14.46	0.99	17.6	1.072
Plat 17.	Sept. 2	111	78	42.6	55	12.38	1.58	15.2	1.066
10 lbs. Dried Blood....	Sept. 9	100	70	33.6	48	11.31	1.49	14.4	1.059
	Sept. 18	87	64	31.3	49	12.73	1.30	16.8	1.067
	Sept. 25	94	72	33.6	47	13.86	1.07	17.6	1.074
Plat 18.	Sept. 2	88	62	32.1	51	13.13	1.39	16.2	1.066
15 lbs. Dried Blood....	Sept. 6	94	68	34.0	50	12.47	1.70	16.4	1.066
	Sept. 19	104	72	37.5	52	14.46	1.30	18.0	1.075
	Sept. 25	62	48	16.6	35	14.77	0.71	17.6	1.073
Plat 19.	Sept. 2	104	77	39.8	51	13.13	1.39	16.2	1.066
Nothing.....	Sept. 6	121	89	45.7	51	12.73	1.49	16.2	1.064
	Sept. 18	82	62	32.6	52	10.37	1.95	14.0	1.056
Plat 20.	Sept. 25	54	36	17.4	48	14.14	1.84	17.6	1.073
7½ lbs. Acid Phosphate	Sept. 2	96	67	30.1	45	11.10	1.43	15.2	1 061
7½ Kainit	Sept. 6	87	64	32.5	51	12.26	2.17	15.8	1.065
	Sept. 18	90	69	34.5	50	13.83	1.22	17.2	1.069
	Sept. 25	68	54	23.5	43	14.61	1.44	17.2	1.074
Plat 21.	Sept. 2	86	66	34.1	51	13.66	1.30	16.8	1.068
2½ lbs. Kainit..... ..	Sept. 6	108	78	42.9	55	12.57	1.36	15.8	1.065
	Sept. 18	96	72	37.5	52	13.20	1.38	16.8	1.067
	Sept. 25	68	52	20.9	40	15.50	1.43	18.6	1.076

EARLY ORANGE.

	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
	Sept. 2	78	59	28.9	49	12.73	1.56	15.5	1.065
Plat 22.	Sept. 6	84	60	24.0	40	13.83	1.34	17.2	1.070
5 lbs. Kainit	Sept. 18	78	62	27.5	45	14.46	1.19	17.6	1.073
	Sept. 25	68	52	20.9	40	15.50	1.43	18.6	1.076
	Sept. 2	86	76	41.4	55	12.63	1.77	15.8	1.064
Plat 23.	Sept. 6	88	66	27.7	42	12.73	1.62	15.8	1.066
7½ lbs. Kainit	Sept. 18	88	74	35.9	49	14.5	1.29	17.2	1.071
	Sept. 24	70	62	21.8	44	16.66	0.97	19.8	1.082
	Sept. 2	100	74	34.0	46	12.66	1.43	15.8	1.065
Plat 24.	Sept. 6	100	75	38.7	51	12.57	1.61	16.0	1.065
10 lbs. Kainit	Sept. 18	102	76	36.4	48	13.36	1.39	17.0	1.068
	Sept. 24	93	76	33.8	44	16.21	1.12	19.4	1.081
	Sept. 2	102	66	35.6	54	13.07	1.62	16.0	1.066
Plat 25.	Sept. 6	77	56	27.5	49	11.94	2.36	15.8	1.066
12½ lbs. Kainit	Sept. 17	96	72	36.8	50	13.20	1.49	16.4	1.066
	Sept. 24	44	33	13.8	42	12.13	1.58	16.0	1.065
Plat 26.	Sept. 2	104	82	45.6	56	13.20	1.90	16.0	1.066
15 lbs. Kainit	Sept. 6	84	64	33.5	52	11.69	2.18	15.2	1.060
Plat 27.	Aug. 29	89	71	39.0	55	13.51	3.22	17.0	1.070
	Sept. 6	77	55	27.0	49	11.56	2.46	15.2	1.063
Plat 28.	Aug. 29	88	66	33.4	50	11.94	2.93	16.0	1.065
5 lbs. Acid Phosphate	Sept. 6	80	60	32.1	54	12.32	2.05	16.0	1.066
2½ lbs. Kainit	Sept. 17	96	66	36.0	54	13.71	1.55	15.0	1.063
	Sept. 24	56	42	15.6	37	14.77	1.02	18.0	1.075
Plat 29.	Aug. 29	84	64	31.8	50	13.20	2.23	16.4	1.066
7½ lbs. Acid Phos-	Sept. 6	84	63	32.3	51	12.10	2.33	16.0	1.066
phate	Sept. 17	68	50	27.8	55	11.47	1.73	15.0	1.059
2½ lbs. Kainit	Sept. 24	63	50	19.6	40	16.34	1.67	19.2	1.079
Plat 30.									
10 lbs. Acid Phos-	Aug. 29	105	81	46.1	57	12.26	2.73	16.8	1.064
phate	Sept. 6	92	68	34.3	50	12.51	1.65	16.2	1.065
2½ Kainit	Sept. 17	90	68	34.5	51	13.29	1.70	16.6	1.067
Plat 31.									
2½ lbs. Acid Phos-	Aug. 29	91	74	38.5	52	13.51	2.36	16.8	1.070
phate	Sept. 6	94	64	35.3	55	8.89	2.26	13.0	1.051
5 lbs. Kainit	Sept. 17	100	84	42.8	51	12.32	2.00	15.4	1.062
Plat 32.	Aug. 29	81	64	28.5	45	13.51	2.42	16.8	1.070
2½ lbs. Acid Phos-	Sept. 6	82	65	31.6	49	12.35	1.98	15.6	1.064
phate	Sept. 17	96	76	47.0	62	12.41	1.61	15.6	1.063
7½ lbs. Kainit	Sept. 24	69	56	24.4	44	15.12	0.93	18.8	1.074
Plat 33.									
2½ lbs. Acid Phos-	Aug. 29	86	65	30.9	47	12.98	2.69	16.4	1.068
phate	Sept. 5	60	46	23.2	50	13.36	1.67	16.6	1.067
10 lbs. Kainit	Sept. 17	82	44	31.8	50	12.57	1.58	16.0	1.064
Plat 34.									
5 lbs. Acid Phosphate	Aug. 29	89	71	33.3	47	12.88	2.54	16.0	1.067
5 lb. Kainit	Sept. 5	102	80	46.0	58	11.16	2.05	14.6	1.059
	Sept. 17	104	80	43.0	54	12.19	1.46	15.4	1.062

EARLY ORANGE.

	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Plat 35.									
10 lbs. Acid Phos-	Aug. 29	88	70	32.6	47	13.36	3.05	17.0	1.070
phate	Sept. 5	95	70	33.5	48	11.63	1.14	16.0	1.059
10 lbs. Kainit	Sept. 17	112	90	28.4	32	12.41	1.42	15.4	1.063
Plat 36.	Aug. 29	101	76	38.6	51	13.83	2.63	17.6	1.072
250 lbs. Barnyard Ma-	Sept. 5	112	83	45.7	54	12.57	1.24	16.2	1.065
nure.	Sept. 17	88	68	32.4	48	11.78	1.30	15.4	1.061
Plat 37.	Aug. 29	84	64	32.8	50	14.46	2.10	18.0	1.075
500 lbs. Barnyard Ma-	Sept. 5	97	75	41.7	55	12.73	1.30	16.0	1.065
nure.	Sept. 17	88	62	45.8	74	12.10	1.30	15.6	1.062
	Sept. 24	36	29	11.6	40	15.30	1.03	18.4	1.075
Plat 38.	Aug. 29	92	68	29.6	44	14.30	2.36	17.6	1.072
750 lbs. Barnyard Ma-	Sept. 5	88	66	34.5	52	12.10	1.92	15.6	1.062
nure.	Sept. 17	96	76	33.5	44	11.94	1.24	15.2	1.061
	Sept. 24	32	21	8.3	40	15.05	0.96	18.8	1.074
Plat 39.	Aug. 29	103	78	42.1	54	14.23	2.34	18.2	1.072
1000 lbs. Barnyard Ma-	Sept. 5	112	79	38.9	49	13.20	1.34	16.6	1.068
nure.	Sept. 17	88	68	39.0	58	12.57	1.22	15.8	1.066
	Sept. 24	42	33	13.3	40	12.73	2.99	17.2	1.070
Plat 40.	Aug. 29	86	63	29.9	47	14.47	2.32	18.2	1.075
250 lbs. Barnyard Ma-	Sept. 5	93	76	30.0	39	13.51	1.12	17.2	1.071
nure,	Sept. 17	84	64	33.1	52	10.84	1.24	14.4	1.058
7½ lbs. Acid Phosphate	Sept. 24	62	49	19.9	41	15.09	1.18	18.0	1.077
	Sept. 2	124	88	50.1	57	12.29	2.63	15.6	1.064
Plat 41.	Sept. 20	70	54	23.4	44	10.37	2.54	14.0	1.053
Nothing	Sept 20	80	54	26.9	50	12.29	1.92	16.0	1.062
	Sept. 27	78	59	28.8	49	13.61	2.13	17.6	1.071

EARLY AMBER.

	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Plat 13.	Aug. 20..	64	51	25.6	50	11.94	2.91	15.4	1.061
15 lbs. Acid Phosphate	Aug. 28..	76	60	29.6	49	13.04	2.71	17.0	1.068
Plat 14.	Aug. 16..	65	47	26	55	9.02	2.50	12.4	1.052
2½ lbs. Dried Blood ...	Aug. 20..	81	61	34.6	56	11.16	3.00	14.5	1.059
	Aug. 28..	108	80	38.8	49	10.50	3.17	14.8	1.059
Plat 15.	Aug. 15..	79	58	31.4	54	19.68	3.71	13.6	1.056
5 lbs. Dried Blood	Aug. 20..	78	62	33.1	54	13.06	2.99	16.2	1.065
	Aug. 28..	80	62	31.3	50	12.57	2.69	16.6	1.067
Plat 16.	Aug. 15	64	42	29.4	56	9.87	5.45	15.0	1.062
7½ lbs. Dried Blood....	Aug. 20	58	45	21.8	48	14.17	2.23	17.2	1.069
	Aug. 28..	76	58	30.9	53	11.94	2.29	16.0	1.064
Plat 17.	Aug. 15..	61	47	26.1	56	12.76	3.14	16.0	1.065
10 lbs. Dried Blood.....	Aug. 20..	84	64	35.1	56	12.98	2.73	15.6	1.060
	Aug. 28..	62	46	22.1	48	13.07	2.56	17.2	1.071
Plat 18.	Aug. 15..	76	54	30.8	57	10.50	2.67	14.4	1.059
15 lbs. Dried Blood.....	Aug. 20..	64	46	25.7	55	12.85	2.36	16.0	1.065
	Aug. 28..	64	48	24.8	51	13.45	2.19	17.0	1.071
Plat 19.	Aug. 15..	62	44	24.5	56	7.96	5.22	13.4	1.057
Nothing..	Aug. 20..	64	48	24.5	51	71.88	2.48	15.0	1.060
	Aug. 27..	99	67	41.9	63	11.85	2.57	16.6	1.062
Plat 20.	Aug. 15..	66	48	27.3	57	10.15	4.11	15.0	1.060
7½ lbs. Acid Phosph'e	Ang. 19..	78	57	30.3	54	8.33	2.54	12.0	1.047
7½ lbs. Kainit	Aug. 27..	80	62	32.6	53	11.63	2.21	15.0	1.062
Plat 21.	Aug. 14..	75	62	32.3	52	12.73	2.79	16.0	1.064
2½ lbs. Kainit..	Aug. 19..	84	62	33.5	54	9.36	1.93	13.0	1.051
	Aug. 27..	76	57	29.9	52	10.31	2.29	14.2	1.058
Plat 22.	Aug. 14..	72	57	29.3	51	10.24	2.49	13.5	1.054
5 lbs. Kainit..	Aug. 19..	81	64	32.6	51	19.36	2.74	13.0	1.052
	Aug. 27..	95	73	38.0	52	10.94	2.36	14.4	1.060
Plat 23.	Aug. 14..	88	69	36.4	53	9.92	2.51	12.5	1.048
7½ lbs. Kainit..	Aug. 19..	88	67	36.8	55	8.05	2.32	11.5	1.049
	Aug. 27..	90	74	40.3	54	12.26	2.23	15.7	1.064
Plat 24.	Aug. 14..	64	49	25.1	57	9.02	2.55	12.4	1.050
10 lbs. Kainit	Aug. 19.	83	66	35.7	54	9.58	2.17	12.8	1.052
	Aug. 27..	72	55	28.3	52	9.27	2.67	13.0	1.052
Plat 25.	Aug. 14..	60	46	24.7	54	10.50	3.48	14.2	1.056
12½ lbs. Kainit	Aug. 19..	84	66	35.5	54	9.24	1.92	12.2	1.050
	Aug. 27..	81	64	34.1	51	11.13	2.94	14.8	1.060
Plat 26.	Aug. 14..	66	52	26.8	52	10.47	2.75	13.6	1.054
15 lbs. Kainit	Aug. 19..	85	67	36.1	54	12.19	1.99	15.0	1.063
	Aug. 27..	98	76	41.5	53	11.16	2.37	14.4	1.060
Plat 27.	Aug. 14..	72	58	29.7	51	10.34	2.95	13.6	1.055
2½ lbs. Acid Phosph'e	Aug. 19..	80	64	34.7	54	10.74	2.89	13.6	1.056
2½ lbs. Kainit..	Aug. 27..	76	60	32.9	43	11.78	2.67	15.2	1.063
Plat 28.	Aug. 14..	64	48	21.7	45	10.88	2.78	14.3	1.060
5 lbs. Acid Phosphate..	Aug. 19..	90	65	32.1	49	8.30	2.29	12.0	1.049
2½ lbs. Kainit	Aug. 27..	69	54	25.1	46	12.00	3.29	15.6	1.065

EARLY AMBER.

	DATE.	WEIGHT UNSTRIPPED. OUNCES.	WEIGHT STRIPPED. OUNCES.	WEIGHT OF JUICE.	PER CENT. OF JUICE.	PER CENT. OF SUCROSE.	PER CENT. OF GLUCOSE.	PER CENT. OF SOLIDS BY BRIX.	SPECIFIC GRAVITY.
Plat 29.	Aug. 14	72	58	26.8	46	10.75	2.77	14.1	1.056
7½ lbs. Acid Phosphate	Aug. 19	66	50	22.5	45	9.43	2.52	13.0	1.054
2½ lbs Kainit	Aug. 27	72	56	28.6	51	11.94	2.48	15.6	1.065
Plat 30.	Aug. 14	60	46	22.0	48	10.37	3.82	13.8	1.058
10 lbs. Acid Phosphate	Aug. 19	82	63	34.4	55	10.53	2.64	13.5	1.055
2½ lbs. Kainit	Aug. 27	66	52	25.9	50	9.74	2.69	13.4	1.055
Plat 31.	Aug. 13	60	44	22.0	50	7.98	.....	11.0	1.046
2½lbs. Acid Phosphate	Aug. 19	80	63	32.6	51	9.11	2.70	12.6	1.049
5 lbs Kainit	Aug. 27	77	60	32.3	54	10.06	2.70	13.7	1.055
Plat 32.	Aug. 13	64	44	24.7	56	7.92	.....	11.4	1.047
2½ lbs. Acid Phosphate	Aug. 19	84	67	36.7	55	7.79	2.61	11.0	1.044
7½ lbs. Kainit	Aug. 27	74	54	30.5	57	8.89	2.54	12.8	1.053
Plat 33.	Aug. 13	76	60	34.0	57	9.17	.....	12.7	1.053
2½ lbs. Acid Phosphate	Aug. 19	96	72	40.3	55	9.80	2.42	13.0	1.053
10 lbs. Kainit	Aug. 27	71	56	28.6	51	13.20	1.94	16.4	1.068
Plat 34.	Aug. 13	82	60	32.8	54	11.20	.....	14.2	1.056
5 lbs. Acid Phosphate	Aug. 19	80	64	35.1	55	10.97	2.82	14.1	1.056
5 lbs. Kainit	Aug. 27	69	56	28.6	51	13.10	2.48	16.6	1.068
Plat 35.	Aug. 13	92	74	40.1	54	11.41	.....	14.4	1.059
10 lbs. Acid Phosphate	Aug. 19	86	64	32.6	51	11.00	2.45	14.0	1.057
10 lbs. Kainit	Aug. 26	94	68	37.6	55	11.09	2.51	14.6	1.059
Plat 36.	Aug. 13	83	59	32.6	55	9.96	.....	13.2	1.054
250 lbs. Barnyard manure	Aug. 17	80	59	32.8	56	10.56	.....	14.4	1.048
	Aug. 26	88	68	36.9	53	12.10	2.12	15.4	1.063
Plat 37.	Aug. 13	83	60	31.7	53	8.33	.....	12.0	1.049
500 lbs. Barnyard manure.	Aug. 17	76	50	22.8	46	10.72	.....	14.4	1.041
	Aug. 26	94	74	40.1	54	12.57	2.23	15.4	1.063
Plat 38.	Aug. 13	58	50	25.1	51	10.06	.....	13.2	1.054
750 lbs. Barnyard manure.	Aug. 17	82	60	33.4	55	10.37	.....	14.0	1.054
	Aug. 26	86	62	35.8	58	11.97	2.21	15.4	1.063
Plat 39.	Aug. 13	69	43	21.1	50	7.70	....	11.2	1.048
1000 lbs. Barnyard manure	Aug. 17	74	56	29.8	53	10.47	.....	14.3	1.039
	Aug. 26	92	76	38.8	51	9.14	2.40	12.4	1.051
Plat 40.	Aug. 13	70	50	27.3	55	9.52	.....	13.0	1.052
250 lbs. Barn. manure	Aug. 17	69	50	27.4	56	10.09	.....	14.0	1.042
7½ lbs. Acid Phosphate	Aug. 26	104	75	39.3	54	9.26	3.00	13.0	1.053
	Aug. 15	70	53	27.8	52	10.47	3.78	14.2	1.058
Plat 41.	Aug. 17	82	59	31.5	53	11.56	1.76	15.1	1.058
Nothing	Aug. 26	102	73	41.4	57	8.30	2.67	12.0	1.048
	Aug. 15	82	64	36.7	57	10.37	3.19	14.0	1.056
Plat 42.	Aug. 17	68	37	27.4	74	7.74	1.76	12.0	1.057
Nothing	Aug. 26	102	74	43.5	59	7.92	3.62	12.0	1.047

ENSILAGE.

A. E. MENKE.

The subject of silo building and ensilage has occupied part of our time during the last two years. We did not make any mention of the matter in our first report, as we wished to give the subject another year's trial.

We have now succeeded in making good ensilage two seasons in succession at Pine Bluff and Fayetteville from corn, sorghum and pea vines. These two places are fairly representative of the different climatic conditions prevailing north and south of the mountains. As our silos are to day the first and only ones in the State, and the subject of ensilage is a new one to Arkansas farmers, we deem it advisable to give a complete description of the methods of building silos and preserving ensilage. What cans and the food, etc., preserved in them are to man, so silos and the food (ensilage) preserved in them are to animals. The silo is a pit in the ground or *an air-tight* box above ground for the storage of forage or fodder plants in a moist green state. Ensilage is the material put into and preserved in the silo. In brief, it has now become practicable to cut corn, sorghum, pea vines, clover, etc., while green enough to be a good and nutritious food for animals and store them in a moist, but sound and sweet condition for winter, spring and summer use.

LOCATION OF THE SILO.

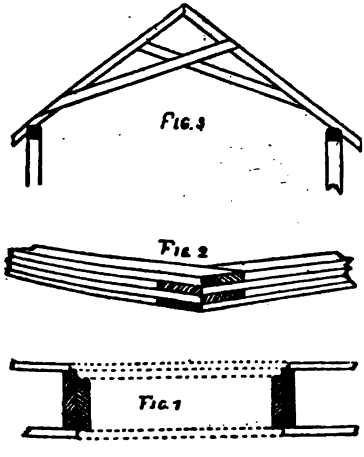
This must greatly depend upon surrounding conditions. It is always a good plan, when practicable, to build the silo inside the barn. This does away with the necessity for a separate roof and also lessens the distance that the ensilage has to be carried to the stock. We have one small silo in our barn at Fayetteville and would have been glad to have had a larger one, the roof being too low compelled us to build one outside. In case you build outside, pick out the driest place you have,

and if that be at all damp, *drain it.* It should always be borne mind that ensilage is a bulky foodstuff and proper attention should be paid to secure a location that will lessen the amount of labor in feeding.

BUILDING.

For the foundation of the structure of an above ground silo, either brick or rock may be used. Prof. A. J. Cook, who has been very successful in silo building, suggests that "the bottom of the silo should be eighteen inches below ground; that the rock wall upon which the silo rests should have the earth to sustain it on the outside. Dig a trench for the stone wall two feet below the bottom of the silo. This is to be filled for a foot with small rock, and if necessary thoroughly drained. The bottom of the silo must be dry. The remainder of the foundation wall should be laid in cement. This wall should be eighteen inches thick below the bottom of the silo. From the bottom of silo to the top of the ground it is only eight inches thick; that is, only the outside of the wall is carried to the top. Thus the inside ten inches of the wall only extends upward to the bottom of the silo, eighteen inches below the surrounding earth."

This makes an excellent foundation; we can advise from our own experience. Upon this wall a sill should be laid which had best be made of 2x10 inch plank. One of the difficulties in silo building is to avoid spreading of the structure, which sometimes occurs through lateral pressure of the contents when settling. For this reason the sills must be well tied together at the corners; instead of using square timbers which are greatly weakened by cutting, plank may be used and the corners of the sills constructed as shown in the accompanying plate, for which we are indebted



to Director Henry, of Wisconsin. If well spiked there will be no danger from spreading at the corners.

Since the *absolutely essential* feature in successful silo building is to have the walls *air-tight*, in order that the contents may be preserved, the following description should be carefully followed:

The sills being laid, we now proceed to erect the building: Put up 2x10 inch studs, crosswise of the wall, not more than sixteen inches apart; double the studding at the corners. Then proceed to close up: On the outside of the studding we put our matched boards, onto which is tacked building paper; then cover the building paper with siding and the outside is complete. We next go to the inside of the studding, nail on boxing, tack building paper on this; then cover with matched boards, so that we have a dead air space the thickness of the studding. The inside boards are painted with coal tar, as this keeps the timber from rotting.

The door to the silo should be about two and one-half feet wide. It extends from the ground to about two feet from the top. As we fill up, the door is closed by using boards and building paper. Building paper is used between the top of the studding and the plates in order to make the dead air space perfect. We put up the roof in the ordinary way, fig. 3 showing how the rafters are tied together so as to least interfere with the filling of the silo. The space between the top of the silo and the roof is ventilated. The walls may be tied together with iron rods ¾-inch in diameter, at right angles to one another. In a twenty foot silo these rods should be about seven feet from the ground. Ours pass through blocks 4 in. x 6 in. x 5 ft. of seasoned oak. These blocks were, however, not strong enough. The bill of lumber employed was as appended. The silo holds 90 tons of ensilage:

Siding	1740 feet.
64 pieces, 2x10x20	2133 "
18 rafters, 2x6x12	324 "
6 studs, 2x4x14	56 "
3 girders, 2x6x16	48 "
8 plates, 2x10x16	215 "
12 sills, 2x12x16	384 "

Matched Flooring.....3200 "
Boxing .....1280 "
Lathing..... 400 "
4 Corner Strips, 1¼x3x20 ..... 25 "
Cornice Lumber..... 126 "
Shingles 4500

DIMENSIONS.

Outside of Building .....16x16 feet.
Height.....20 feet from sills.
Inside.....14⅓x14⅓ feet.

As will be noticed the sills used by us were 2x12 inches, three being employed, these lying one on top of the other would make the sill six inches thick.

SIZE OF SILO.

This will naturally depend upon the amount of stock that it is desired to feed. We may calculate that a cubic foot of ensilage will weigh about forty pounds, and supposing that we have say twenty head of cattle to carry over fourteen weeks, the calculation would be as follows: A ration is about fifty pounds daily per each head, thereupon:

20 head x 50 equals..... 1000 lbs. daily.
98 days x 1000 lbs. equals.....98000 " in 14 weeks.
40 lbs. equals.....1 cubic foot,

$$\frac{98000}{40} \text{ equals} \ldots\ldots 2450 \text{ cubic feet.}$$

Consequently a silo 17x12x12 feet would hold 2448 cubic feet.

The mistake generally made is to build the silo too small. While you are about it, it is just as well to make a good sized one. We have one 20x16x16 feet and would be glad if it was even larger.

The following are the dimensions and bill of lumber for our Pine Bluff Silo:

DIMENSIONS.

Outside.....10 ft. 2 in. x17 ft., 4 in.
Height ..... 11 ft. 2 in. from bottom of sill to top of plate.
Inside ..... 8 ft. 1 in. x 15 ft. 1 in.
Contents.....1428 cubic feet.

MATERIALS USED.

Outside,	54 pieces shiplap siding	1x6x17—459	feet.
"	54 " " "	1x6x10—270	"
"	4 corner boards	1x8x11— 80⅔	"
Inside,	40 pieces	1x12x15—620	"
"	40 "	1x12x48—320	"
Studding	30 "	2x10x11—550	"
Plates,	2 "	2x10x17— 56⅔	"
Sills,	2 "	2x10x18— 60	"
End Plates,	2 "	2x10x10— 33⅓	"
Sleepers for floor,	10 pieces	2x10x10—166⅔	"

TOTAL NUMBER, 2616⅓ feet.

1 Barrel Portland cement, nails, tarred paper.

We do not like the shape of this silo. It was built in 1888 and has, however, made good ensilage two years in succession.

FILLING THE SILO.

Assuming that corn is the food stuff that will be used by most farmers in Arkansas, we say positively: *Never cut the corn until the grains begin to glaze, and do not use corn wet with rain or dew.*

When the right time arrives, cut the plant close to the ground: load up preferably on a low wagon and haul to your feed cutter. We used a Smalley Ensilage cutter, and for power a two-horse sweep. The work went easily. The corn is fed to the machine and cut into pieces about one inch long; the whole plant is cut up, ears, leaves, stalks, and then by means of a carrier is hoisted up and continually drops into the silo. It is not absolutely necessary to fill rapidly; the ensilage does just as well if you cut on alternate days. The carrier should be so arranged as to drop the cut fodder about the middle of the silo. This is advisable because the man in the silo can level it up better. Particular attention should be paid to this point; a man should be in the silo the whole time while the fodder drops in; he should level and tramp it, in order to aid the packing, taking great pains to tread near the walls and especially at the corners. Thorough treading at the edges will alone insure good ensilage right up to the walls and corners. When the silo is full let it rest a day or two; it will settle some; fill it up again; tread the edges and corners thoroughly and then cover

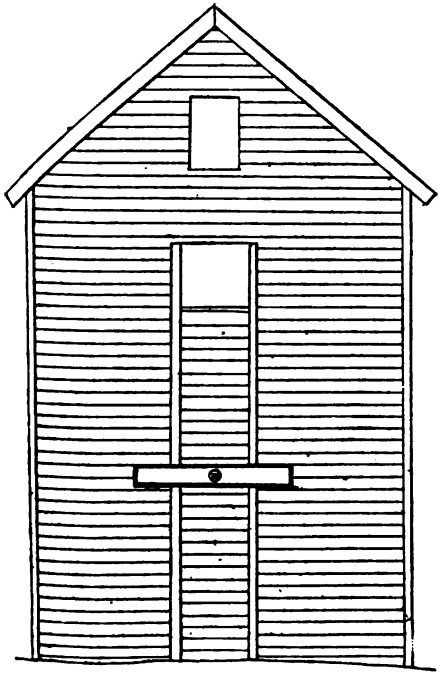
the whole thing with about a foot of straw, on the top of which a few boards may be placed. It is quite unnecessary to put heavy weights on these boards as was formerly done. The man in the silo can, of course, nail up the door as the filling goes on in the manner described previously.

The uncut corn may be used if preferred. We filled a silo in this way and made very good ensilage. If this plan be adopted, fill as follows:

When you put in the corn keep it straight, pack the butts of one tier upon the tops of the preceding tier, crossing at the end and treading the mass closely against the sides.

OPENING THE SILO.

It is usual to wait until the cold weather sets in before opening the silo. At any rate the contents should be quite cold before used. In opening our silo we first of all removed the ventilator and then removed the first two or three pieces from the top of the door, raking off level, and as the feeding progresses we gradually open down the door as required. When whole corn is used, and for the matter of that, cut corn sometimes packs exceedingly close and a heavy knife has to be used to cut the ensilage in the manner of the accompanying plate. We do not open up more of the door than is necessary, and so far have not had the least trouble with it.



MATERIALS USED.

Outside, 54 pieces shiplap siding.....
" 54 " " " .....
" 4 corner boards.....
Inside, 40 pieces.....
" 40 " .....
Studding 30 " .....
Plates, 2 " .....
Sills, 2 " ....
End Plates, 2 "
Sleepers for floor,

1 Barrel Portl

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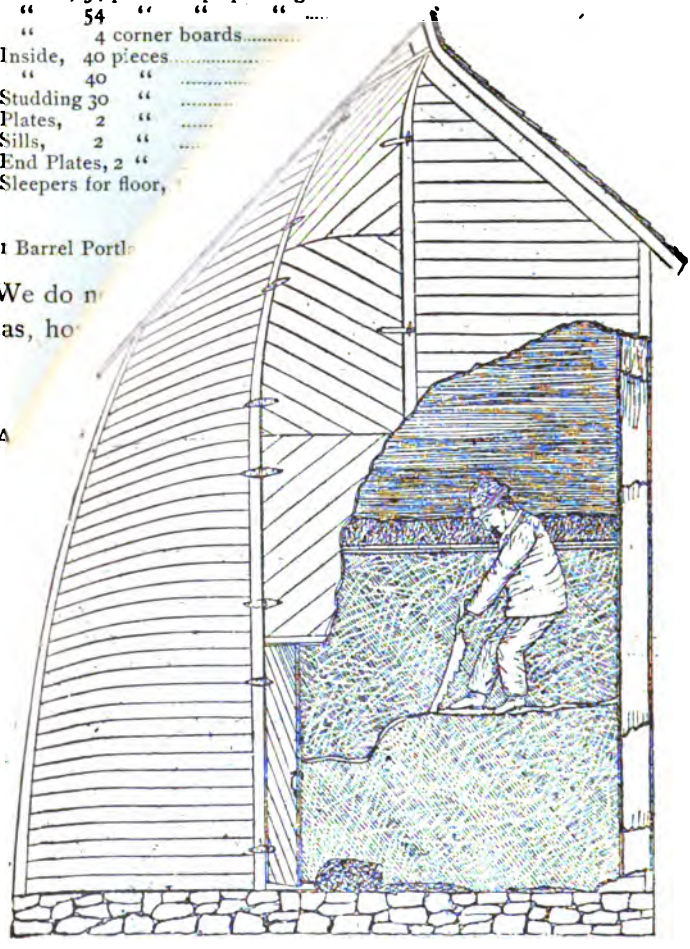

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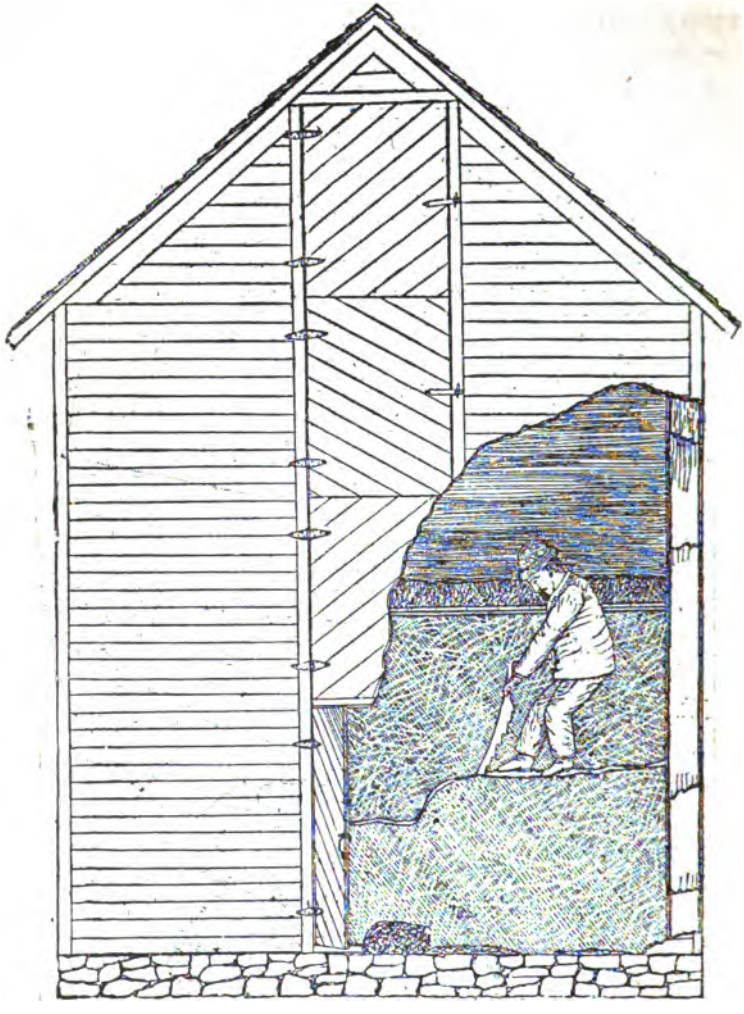

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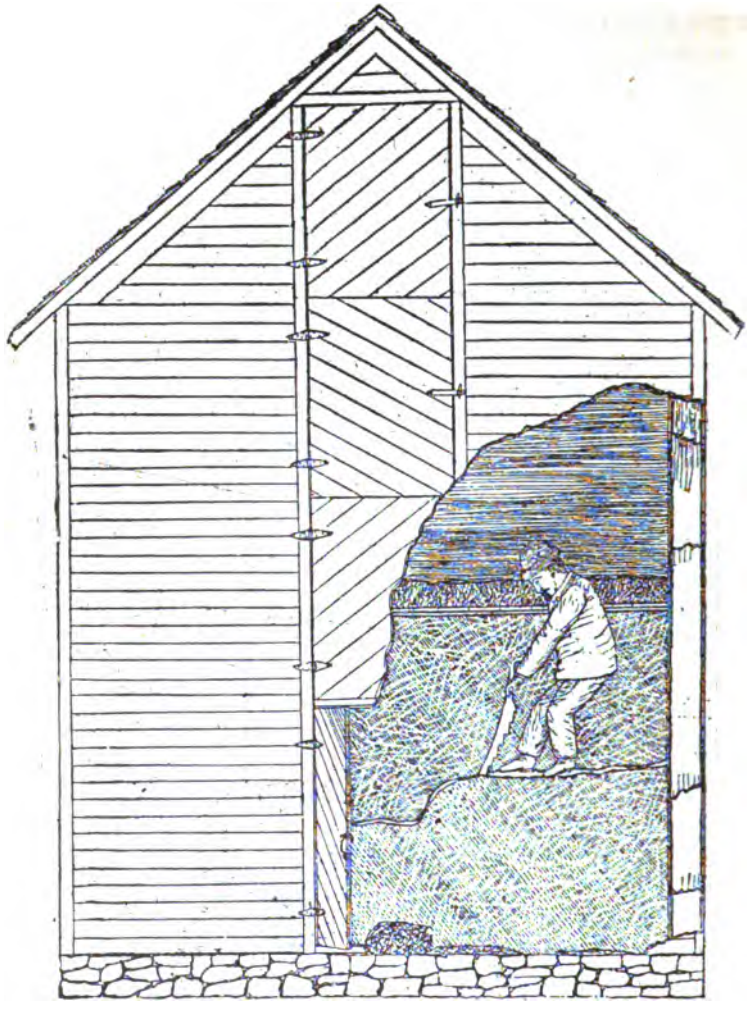

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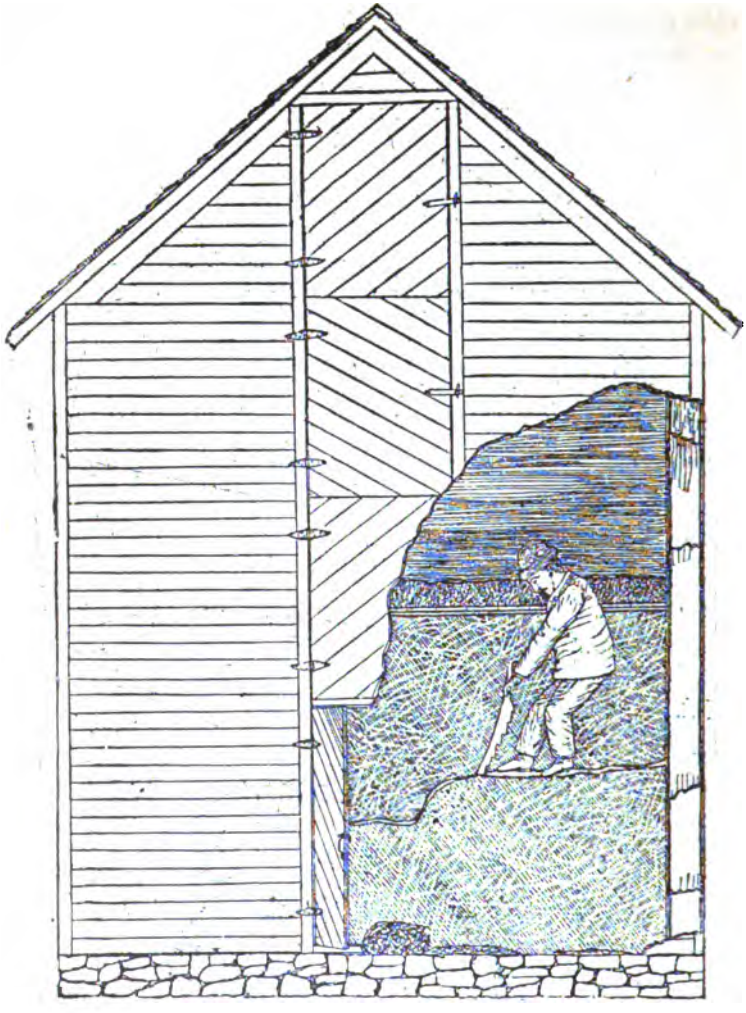

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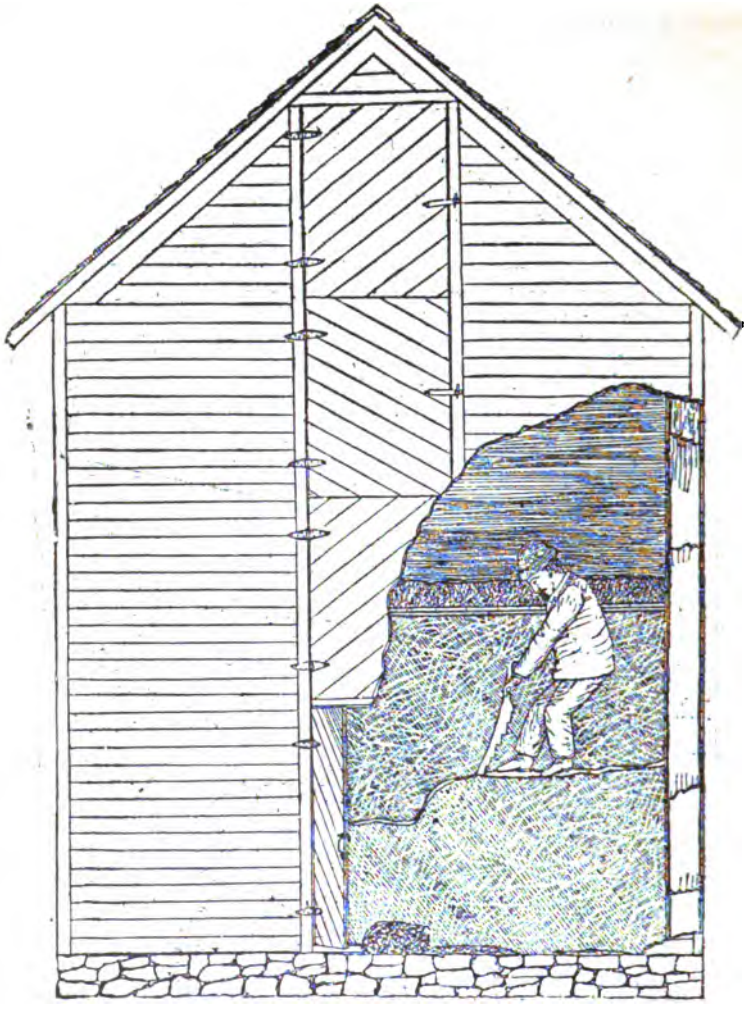

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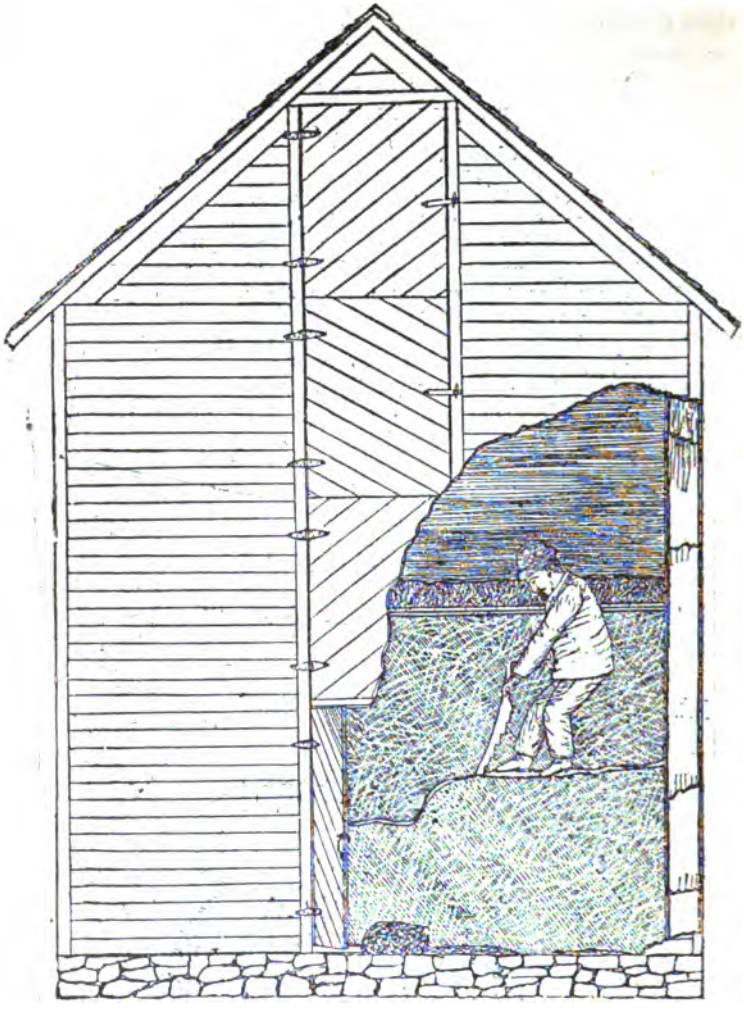

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ters into the calculations of farmers, that I am not aware that any special good can now be accomplished by any attempt on my part to keep before the public the demerits of the silo. I will merely state briefly the merits and demerits of the silo as I understand them, and without any elaboration or attempt at demonstration of the position taken.

On the negative side I observe (*a*): That in perfect drying there is no loss of digestibility or in food value, so far as the World's experiments show. (*b*) That in the silo, food loses by fermentation, in actual weight, and in rotted or spoiled matter, 20 per cent. and upwards, even to 30 per cent. In the dry atmosphere of New Hampshire and Missouri I have found that I can store corn fodder in the barn with less loss than in the silo. (*c*) The building for the storage of a ton of dry matter in air dry form costs less than it does for a ton of dry matter in the form of green food. (*d*) It costs slightly less to harvest food in the air dry state than it does in the green state. (*e*) It costs less to feed out the dry food than it does the green food, for the green food is 1600 pounds of water for every ton. This has not only to be put into the silo, but it has to be carried to the stock in a basket, or is by the average farmer; each basket of ensilage to be shoveled in contains forty pounds of water for every fifty pounds handled. (*f*) In the process of fermentation or slow burning in the silo, in addition to the material actually burned up and spoiled, there is a conversion of food into other and very doubtful products; for instance, proteine is in part converted back into amides, from which it was organized; carbohydrates are transformed into acids, and other changes made that are in all probability injurious. The growth of stock is, I believe, like the milk of cows, of a more watery or of less substantial order.

On the reverse side of the silo question there are some positive virtues; they are: 1st. The fact that they are in a large increase and insurance against the influence of very rainy seasons. For the most of the country, I believe that the loss by burning in the silo is greater than this loss. There are some parts of the country where it is claimed that fodder corn cannot be saved because of the humid atmosphere. In such a case the

silo would have a more decisive value. 2d. Ensilage is a more palatable food than the same food in the dry state. The true and pivotal value of ensilage is wrapped up in this factor. This has not been recognized by its advocates. They have ascribed its value to the fact that it is a green food, to the assumption, (a wrong one) that its fermentation in the silo increased its digestibility and to various other illy considered reasons.

Eighteen pounds of hay is the maintenance ration of a 1000 pound cow. When twenty-four pounds are given, six pounds go to production, or 25 per cent. of the food is productive of milk. When thirty pounds are eaten, 40 per cent. of the total food goes to growth. Palatable foods induce large consumption and thereby increases the ratio of the total food given that enters into growth or milk. When a palatable food is fed and becomes additional to what otherwise would have been eaten, it becomes abnormally valuable, inasmuch as it then practically bears none of the task of support of the cow that must be made before milk or growth can occur. This most valuable function ensilage performs. I doubt whether we can afford to stand 20 or more per cent. of loss that has been reported up to date. Probably the better silos into which ensilage has been put under the best modern conditions will now show a loss of but 15 per cent. If so, this brings the silo upon debatable ground for many farmers. It may be the case that conditions may yet be secured under which the loss is but 10 per cent. If it does occur then I shall feel like advocating the use of the silo for a large number of farmers, especially in dairy districts and where food is high. This winter's work will practically settle the status of the silo.

Very respectfully,

J. W. SANBORN.

COTTON SEED HULLS AS A FOOD STUFF.

A. E. MENKE.

In May, 1889, we published the first bulletin issued on this subject, and since that date, both the Tennessee and Texas Stations have issued reports on the subject, which in the main, agree with our results. The Texas feeding gave results somewhat higher than ours, but on examination it will be found that they fed a larger quantity of meal than we did, their average ration throughout the feeding being *16.52 pounds* of hulls and *6.53 pounds* of meal to each head, resulting as follows:

Total pounds gains of six steers, 1210.

Cost of gain per pound, (hulls $3 per ton, meal $20), 3.63 cents.

Gain per cwt., 27.2 pounds.

Average daily gain, 3.41 pounds.

In order to make this kind of feeding pay, you must put on about 200 pounds.

Steers weighing from 800 to 900 may now be purchased at 1½ cents. They sell, weighing 1000 to 1100 at about 2¾ cents, providing they have the corn fed appearance that this mode of feeding imparts.

A 900 pound steer at 1½c costs	$13 50
200 pounds gain costs (meal $15. ton, hulls $2)	5 26
Total	$18 76

1100 pounds at 2½c. costs $27.50, leaving a gain of $8.74 on each head, from which must be subtracted, freight about $3.00, from Little Rock to St. Louis; interest on capital, etc., so that at present prices the profit is not very big. Fur-

ther, our feeding experiments did not make as good a showing. For particulars, we refer to bulletin 9. We reproduce the description of the manner of feeding at the mills as it is quite interesting.

In the manufacture of cotton seed oil, one ton of seed yields 36 gallons of oil, 700 pounds of meal, and 900 pounds of hulls. The hulls formerly used for fuel, are now generally fed to stock at the various oil mills.

In Little Rock the methods employed are: After coming off the cars, the cattle are put in open yards for some time (about 30 days), to become accustomed to feeding, and to recover from the fever of shipment, which is always present, especially in those brought from Texas. This condition is accompanied by high colored urine. It does not prove serious. The diet at the start is four pounds of meal and about twenty-three pounds of hulls. The regular ration later is eight pounds of meal and twenty-five pounds of hulls per diem This is fed half morning and evening. Hay is given once a week; if manure becomes abnormally soft the hay is increased. A constant supply of fresh well water raised by steam pumps is on hand. The water troughs are frequently cleaned of algae, which collects on the bottom and sides. Salt is always accessible. The period of feeding is about four months. About one per cent. of the cattle scour, but there is no fatality from this cause; it is atributed to the meal and not to the hulls. Scouring cattle are treated by turning out of the sheds into the yard; they are given hay and less meal, but the ordinary ration of hulls is continued; perfectly fresh water is supplied. The duration of scouring is one or two days. Some animals may continue quite loose in the bowels, and yet gain in weight. There is no recurrence of the diarrhoea. The cattle are released and turned into the open yards for a week or two before shipment and fed the same rations as before in troughs. They generally, under these circumstances, feed at night and lie during the day.Cattle are weighed on arrival and departure. None are fed during the summer months.

They sell in Chicago for the full price of Texas fed cattle of the best grade, and pass for corn fed steers.

There is no trouble shipping north from Texas fever regulations. They were bought by an agent in lots during the fall and winter. The best Texas cattle being purchased, averaged in weight from 850 to 950 pounds, and cost, including shipment, about $25 a head. These figures were high. The weight of the cattle when shipped averaged 1699 pounds for the largest, and 1141 for the balance. The age preferred for buying is 4 to 6 years. They are nearly all shipped to Chicago. The monthly gain of *those that did well* was about 75 pounds. The general average is, in our opinion, not over 35 to 40 pounds. There is no refuse of food. If the cotton seed hulls are stored they sweat and spoil and are not fit for use. They must be fresh or will cause scouring. They will never keep stored over two months. The meal should be bright yellow and free from large black particles. The hull should not contain seed. On examination of the cattle by our veterinarian, Dr. Dinwiddie, he states that the cattle were in good health and one lot ready for shipment were equal to the average condition of northern stall wintered cattle. None of them were in poor condition. There had been very little fatality or disease. One had lumpy jaw. Three that died on post mortem showed the cause to have been pleuro-pneumonia brought on by over exposure. It was found that cattle fed in the open took more food to get equal results. Consequently shed feeding was adopted. We fed four head at Fayetteville in a preliminary test with somewhat discouraging results, and had intended continuing the tests at the Little Rock mills this fall as soon as they commenced feeding; they have however for some reason not as yet commenced, and, consequently we must wait. In the mean time we are making experiments feeding hulls and meal to young calves with the results as tabulated.

FEEDING CALVES ON HULLS AND MEAL.

WEEKLY GAIN.

CALVES.	WEIGHT. NOV. 26.	WEIGHT. DEC. 3.	WEIGHT. DEC. 10.	WEIGHT. DEC. 17.	WEIGHT. DEC. 24.	WEIGHT. DEC. 31.	WEIGHT. JAN. 7.	WEIGHT. JAN. 14.	WEIGHT. JAN. 21.	WEIGHT. JAN. 28.
A	361	344	325	332	349	368	374	374	380	400
B	290	279	276	298	296	330	340	350	350	353
C	208	224	219	240	240	270	276	276	280	299
D	196	200	200	216	224	238	238	235	240	247
E	186	192	190	214	224	238	238	245	245	260
F	188	190	190	214	210	234	235	238	241	255
G	.....	.....	.....	.....	221	224	240	245	258	265
H	.....	.....	.....	.....	166	175	180	184	.....	.....
I	.....	.....	.....	.....	.....	.....	170	180	186	194

The calves fed in this experiment are grades of different varieties, and since at this date we have only fairly started the feeding, we will reserve all details as to amount of food consumed, cost of grain, etc., for a future publication. The calves all look healthy and are doing well.

A most important piece of information came to us that *packers were avoiding and some refusing stock fed on cotton seed products*, alleging that it makes a meat that neither keeps nor cures as well as meat from corn fed animals. This being of great interest to Arkansas feeders, we are feeding stock of different kinds in this way so that at the proper time we will have them subjected to such expert judgement and tests as will effectually settle the question.

HORTICULTURAL DEPARTMENT.

E. S. RICHMOND, A. F. CORY.

STRAWBERRIES.

It is our object in this report to give an account in a condensed form, of the different varieties of Strawberries growing on the Experiment Station grounds.

The results given are only for the year '89, the plants being set in the Spring of 1888. The soil is a sandy loam, and was fertilized with three hundred pounds of Kainit and three hundred and fifty pounds of Nitrate of Soda to the acre. They were grown in matted rows and covered during the winter with forest leaves; in the spring the leaves were raked off the plants, where they were so thick as not to allow the plants to grow up through them, and left between the rows to serve both as a mulch and to keep the berries out of the dirt.

TIME TO PLANT.

The plants can be set either in the spring or fall; if set by the first of September they will yield enough the next spring to pay for the extra labor required.

PLANTING.

The first thing essential to success is to have the ground well prepared before setting the plants. Deep plowing and thorough pulverization is quite necessary. When ready to plant take a plow and mark off the ground, making the rows 3½ or 4 feet apart. Take a knife and cut off the dead leaves and trim the roots back to about three inches. Avoid using old plants, as their roots are usually partially dead and they will not start like good healthy young ones. Place them in a convenient vessel with sufficient water to cover the roots. In setting the plant be careful that the roots do not become bunched up as in Fig. 2, but spread them out evenly in all directions; draw the loose earth over the roots and press it firmly about them. Fig. 1 is an example of a plant with the roots spread out and set in the proper way.

Figure 1

Figure 2.

Figure 3.

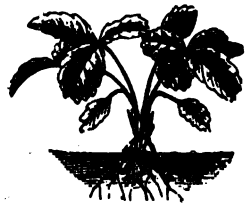


Figure 4.

Be careful that the plant is in the earth to the proper depth. Fig. 3 represents a plant with the crown covered up with earth. Plants set in this manner will be smothered if the weather is wet.

Fig. 4 represents a plant set too shallow and is equally as bad as setting too deep; too much of the plant is exposed to the air and it will soon wither and die.

All weeds should be kept down from the very first; once let them get a start in the row and they will have to be removed with a hoe or by hand.

The distance apart in the row to plant them varies with different varieties. A variety producing many runners may be set two feet or more apart, while a variety producing few runners should be set about one foot apart.

BLOSSOMS.

Strawberry blossoms are divided into two classes: First, Staminate or perfect flowering, as in Fig. 5, and second, Pistillate, or imperfect flowering, as in Fig. 6. The, so called, Staminate varieties have both stamens (male organs) and pistils (female organs), and are therefore self-fertilizing. The Pistillate varieties have no stamens and must have some perfect flowering variety set every fourth or fifth row to fertilize them. All Pistillate varieties are marked thus: (P).

Figure 5.

Figure 6.

VARIETIES.

Figure 7.

Atlantic, Fig. 7—Medium in size; berry firm and good; first picking May 10; last picking June 10; prolific; slightly affected by leaf-blight.

Belmont—Berry large and firm; quality poor; first picking May 10; last picking June 7; not prolific; leaf-blight affects it very little.

Bidwell—Large and irregular; berry firm; quality poor; first picking May 8; last picking May 30; not prolific; this variety set a very heavy crop of berries, but many of them failed to develope; leaves blight a little.

Big Bob (P)—Large; berry firm and quality fairly good; first picking May 15; last picking May 30; not prolific; slightly affeeted by leaf-blight.

Figure 8.

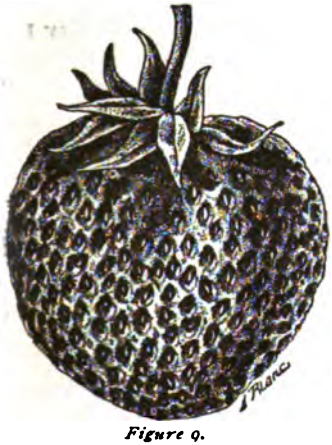


Figure 9.

Bubach No. 5 (P), *Fig. 8*—Large and moderately firm; quality good; first picking May 11; last picking June 10; is the best bearer in our collection, and the berries remain uniformly large throughout the bearing season; is just noticeably affected by the leaf-blight.

Captain Jack, *Fig. 9*—Medium in size; berry firm and good; first picking May 11; last picking June 5; prolific; slightly affected by leaf-blight.

Charles Downing—Large; rather soft; good; first picking May 11; last picking June 10; prolific; slightly affected by leaf-blight.

Champion—Size medium; soft; good; first picking May 10; last picking May 30; not prolific; slightly affected by leaf-blight.

Crescent (P)—Size medium; moderately firm; fair quality; first picking May 8; last picking June 7; prolific; blighted slightly.

Crimson Cluster (P)—Size medium; moderately firm and fair quality; first picking May 8; last picking June 10; prolific; free from leaf-blight.

Crystal City—Small; soft and poor quality; first picking May 2; last picking May 8; not prolific; leaves are blighted a little.

Cumberland, or Jumbo—Large; soft; good; first picking May 10; last picking June 5; not prolific; slightly affected by leaf-blight.

Daniel Boone—Large; firm and good; first picking May 11; last picking June 3; prolific; slightly affected by leaf-blight.

Early Canada—Medium; firm and good; first picking May 4; last picking May 25; not prolific; slightly affected by leaf-blight.

Glendale—Medium; firm; poor; first picking May 6; last picking June 3; not prolific; slightly affected by leaf-blight.

Figure 10.

Hart's Minn.—Small; soft; good; first picking May 10; last picking May 24; not prolific; slightly affected by leaf-blight.

Henderson — Medium; firm and good; first picking May 15; last picking May 31; not prolific; very little leaf-blight.

James Vick—Medium; firm and good; first picking May 13; last picking June 10; prolific; no leaf-blight.

Jersey Queen (P)—Small; soft; good; first picking May 10; last picking June 3; not prolific; a little leaf-blight.

Jessie, *Fig. 10*—Large, firm and good; first picking May 7; last picking May 31; prolific; a little leaf-blight.

Figure 11.

Jewell (P), *Fig. 11*—Large; rather soft; good; first picking May 15; last picking May 24; not prolific; no leaf-blight,

Kentucky — Medium; soft; good; first picking May 10; last picking June 10; prolific; no leaf-blight.

Legal Tender — Large, good and firm; first picking May 10; last picking June 3; prolific; very little leaf-blight.

Mam. Seedling—Large, soft and good; first picking May 15; last picking June 10; not prolific; slightly affected by leaf-blight.

Manchester—Medium; moderately firm; poor; first picking May 8; last picking June 7; not prolific; very little leaf-blight.

Figure 12.

May King, Fig. 12.—Large; moderately firm; good; first picking May 6; last picking June 10; prolific; no leaf-blight.

Monarch—Large, soft and good; first picking May 10; last picking June 3; prolific; very little leaf-blight.

Mt. Vernon—Medium; soft; poor; first picking May 15; last picking June 10; prolific; slightly affected by leaf-blight.

Miner—Medium; soft; fair quality; first picking May 18; last picking May 30; not prolific; no leaf-blight.

Mrs. Garfield (P)—Medium; firm; fair quality; first picking May 14; last picking June 10; not prolific; a little leaf-blight.

Old Ironclad—Medium; firm; good; first picking May 7; last picking May 24; not prolific; a little leaf-blight,

Figure 13.

Parry—Medium; soft; good; first picking May 11; last picking June 5; not prolific; slightly affected by leaf-blight.

Piper—Medium; soft; fair quality; first picking May 15; last picking June 7; prolific; a little leaf-blight.

President Lincoln — Small and rather soft; poor; first picking May 15; last picking June 5; prolific; a little leaf-blight.

Primo—Medium; firm; poor; first picking May 13; last picking June 3; not prolific; some leaf-blight.

Prince of Berries—Medium; firm; good; first picking May 15; last picking June 3; prolific; some leaf-blight.

Sharpless, Fig. 13—Large, firm and good; first picking May 11; last picking June 3; prolific; a little leaf-blight.

Warner—Of this variety we have but a few plants and they were unproductive.

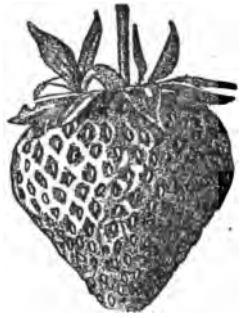


Figure 14.

Wilson, Fig. 14—Small; firm; fair quality; first picking May 8; last picking June 3; prolific; quite badly affected by the leaf-blight.

Windsor Chief (P) — Small soft; good; first picking May 9; last picking June 3; not prolific; some leaf-blight.

The varieties given below were planted in the spring of '89, therefore we can only give condition of plants as taken from our field notes of July 15. The notes on leaf-blight were taken at the same time for all the varieties.

Bubach No. 132 (P)—Has made a good growth and is free from leaf-blight; plants all alive.

Burt—Looks well; has some leaf-blight; 86 per cent, of plants alive.

Carmichael—A poor growth; has some leaf-blight; plants all alive.

Clara—Looks well; some leaf-blight; plants all alive.

Clingto (P)—A good growth, some leaf-blight; plants all alive.

Cloud (P)—Looks well; some leaf-blight, plants all alive.

Daisy—Has made a good growth; some leaf-blight; 93 per cent. alive.

Eureka (P)—Has made a good growth; some leaf-blight; 92 per cent. alive.

Gandy's Pride—Looks well; some leaf-blight; plants all alive.

Gold (P)—Has made a good growth; no leaf-blight; 95 per cent. of plants alive.

Gypsy—Has done well; some leaf-blight; 88 per cent. alive.

Haverland (P)—Has made a good growth; no leaf-blight; 97 per cent. of plants alive.

Hoffman—A good growth; some leaf-blight; 93 per cent. of plants alive.

Lady Rusk (P)—Looks well; no leaf-blight; 90 per cent. of plants alive.

Logan (P)—Looks well; no leaf-blight; 47 per cent. alive. This variety was planted where there had been an old manure pile, and in May quite a number of larvæ of the May Beetle were found about the roots, which accounts for the low percentage of live plants.

Louise—A good growth; some leaf-blight; plants all alive.

Miami (P)—A good growth; some leaf-blight; 85 per cent. of plants alive.

Monmouth—A good growth; some leaf-blight; 95 per cent. of plants alive.

Ohio (P)—Has made a good growth; some leaf-blight; 95 per cent. of plants alive.

Ontario—Has made a good growth; some leaf-blight; plants all alive.

Parker Earle—A good growth; some leaf-blight; 85 per cent of plants alive.

Pearl—A good growth; some leaf-blight; 96 per cent. of plants alive.

Warfield No. 2 (P)—Has made a good growth; is free from leaf-blight; 93 per cent. of plants alive.

BRANCH STATION AT PINE BLUFF.

NAME OF VARIETY.	FIRST RIPE.	LAST RIPE.	YIELD.	SIZE.	CHARACTER OF FRUIT.	EFFECT OF THE LEAF BLIGHT ON PLANT.
Atlantic	May 1	May 31	Good	Large	Firm...	Some leaf-blight
Bidwell	May 4	May 20	Poor	Medium	"	No leaf-blight
Big Bob (P)	No Berries					
Bubach No. 5 (P)	May 1	May 28	Good	Large	Soft	No leaf-blight
Chas. Downing	May 4	May 31	Poor	Medium	"	Badly affected
Champion	May 6	May 31	"	"	"	Slightly affected
Crescent (P)	April 24	May 24	Good	Small	Firm...	No leaf-blight
Crimson Cluster (P)	April 27	May 28	"	"	"	No leaf-blight
Crystal City	April 20	May 11	Poor	"	Soft	Slightly affected
Daniel Boone	April 27	May 25	Fair	Large	"	" "
Early Canada	April 20	May 24	Poor	Medium	"	Badly affected
Finch Seedling	May 1	June 3	"	Large	Firm...	" "
Glendale	May 1	June 5	"	Medium	"	" "
Hart's Minnesota	May 1	May 24	"	Small	Soft	" "
Henderson	May 1	May 31	"	"	"	" "
James Vick	April 27	May 31	"	Medium	"	" "
Jersey Queen (P)	April 24	May 31	Fair	"	"	Slightly affected
*Jessie	April 24	May 24	Poor	Large	"	" "
Jewell (P)	May 4	May 28	Fair	Medium	Firm...	" "
Jumbo (Cumberl'd)	May 1	June 3	"	Large	Soft	" "
Kentucky	April 27	May 28	"	Medium	Firm...	" "
Legal Tender	April 27	May 31	Good	"	Soft	" "
Mm. Seedling	May 4	May 31	Poor	Large	"	" "
May King	May 26	June 3	Good	Medium	Firm...	" "
Miner			Poor	"	Soft	" "
Monarch	May 1	June 3	Fair	Large	"	" "
Mt. Vernon	May 6	June 3	"	Medium	Firm...	" "
Mrs. Garfield (P)	May 6	May 31	"	"	"	Badly affected
Old Ironclad			Poor	Small		Slightly affected
Parry	May 4	May 28	"	Large	Soft	" "
Piper	April 27	May 28	"	Medium	"	" "
President Lincoln	May 4	May 28	"	Small	Firm...	Badly affected
Primo	May 6	May 28	"	Medium	Soft	" "
Prince of Berries	May 2	May 31	"	Small	Firm...	Slightly affected
Wilson	April 27	May 24	Good	Medium	"	" "
Windsor Chief (P)	May 2	May 26	"	"	"	" "

*The Jessie blossomed profusely but the berries did not set well.

In no case was the exact yield of any of these varieties determined, but judging from general appearance we would say that the Early Canada, among the early, and the Bubach No. 5, among the late varieties, yield better than any other; and that the Crescent, Wilson, May King, Atlantic and Crimson Cluster gave the next best yields in the order named.

The failure of the Big Bob to produce berries was probably due to the fact that no staminate variety blooming at the same time was very near it.

VARIETIES PLANTED SPRING OF 1889.

VARIETIES.	EFFECT OF LEAF-BLIGHT ON PLANTS.	CHARACTER OF GROWTH.	PER CENT. OF LIVE PLANTS JULY 1.
Burt	Slightly affected	Good	93
Bubach No. 132 (P)	" "	"	80
Carmichael	Badly affected	Poor	86
Clara	" "	Good	100
Clingto (P)	Slightly affected	"	100
Daisy	" "	"	100
Eureka (P)	" "	"	100
Gandy's Pride	" "	"	100
Gold (P)	" "	"	100
Gypsy	" "	Poor	42
Haverland (P)	" "	Good	100
Hoffman	" "	"	100
Logan (P)	" "	Poor	92
Louise	" "	Good	86
Miami (P)	" "	"	92
Mammoth	" "	"	100
Ohio (P)	" "	"	100
Ontario	" "	"	92
Pearl	" "	Poor	57

SWEET POTATOES.

A plat of ground containing one-tenth acre was taken and set with Southern Queen sweet potatoes. One-fourth of this was fertilized with six pounds dried blood and five pounds nitrate of soda and yielded 265 pounds of potatoes. The second fourth was fertilized with six pounds cotton seed meal and five pounds of Kainit, and yielded 239 pounds of potatoes. The third fourth was fertilized with four pounds acid phosphate, three pounds dried blood and two pounds Kainit and yielded 232 pounds of potatoes. The remaining fourth was left unfertilized and yielded 256 pounds of potatoes.

A second plat of one-twentieth acre was taken and planted with one row each of South Carolina, Yellow Nansemond, Red Nansemond and Bermuda. The first half of the plat was fertilized with ten pounds of wheat bran and four pounds of Kainit.

The other half was unfertilized. Each row was thus half fertilized and half unfertilized. The yield of the fertilized half was

South Carolina	36 pounds
Yellow Nansemond	47 "
Red Nansemond	56 "
Bermuda	89 "

The yield of the unfertilized half was

South Carolina	30 pounds
Yellow Nansemond	33 "
Red Nansemond	52 "
Bermuda	61 "

It will be seen that in no case but the last, when wheat bran and Kainit were used, did the fertilizer make enough increase to pay for cost and application of fertilizer.

SEED GERMINATION TESTS.

All of the tests, except peas and beans, were conducted under shelter; the temperature ranging from 58 to 80 degrees, Fahr.

Seeds tested under cloth were placed between two layers of heavy black cloth and kept constantly moist. Those planted in earth were in boxes, the earth being kept constantly moist.

The object of these tests, was to ascertain what per cent. of seeds would grow, and to see if seeds bought of different seedsmen and dealers were about the same.

J. C. Vaughan's seeds were received direct from Chicago. Landreth's seeds were purchased of a local dealer in Pine Bluff, and it will be noticed some of them were quite poor. Before buying garden seeds, it would be well to be sure your local dealer has new seeds. L. E. Archais' seeds were bought direct from his seed store in Fayetteville.

RADISH SEED.

VARIETIES.	PER CENT. GERMINATED IN EARTH.	PER CENT. GERMINATED UNDER CLOTH.	SEEDS FROM
Cal. Mm. White Winter	96.	100.	J. C. Vaughan, Chicago, Ill.
Chinese Mm. Winter	96.	100.	
China Rose Winter	88.	88.	
Earliest Carmine Erfurt	64.	84.	
Early Deep Scarlet Turnip	68.	90.	
Early Scarlet Turnip	96.	97.	
Early White Giant Stuttgart	100.	86.	
Extra Early Scarlet Globe	88.	97.	
French Breakfast	80.	94.	
Golden Yellow Summer Turnip	88.	95.	
Grey's Summer Turnip	100.	91.	
Half Long Deep Scarlet	84.	83.	
Imperial Chartiers	44.	63.	
Long Black Spanish	96.	97.	
Long Scarlet Short Top	80.	91.	
Long White Naples	96.	97.	
Long White Vienna	92.	94.	
Olive Shaped White	76.	74.	
Olive Shaped Deep Scarlet	84.	94.	
Round Black Spanish	96.	93.	
Scarlet China Winter	72.	74.	
Scarlet Turnip Non Plus Ultra	68.	55.	
Scarlet Turnip, White Tipped	100.	100.	
Shepherd	92.	97.	
Vaughan's Olive Shaped Scarlet Short Top	96.	85.	
White Strausburg	92.	97.	
White Turnip	76.	70.	
Wood's Early Frame	88.	94.	
Yellow Summer Turnip	68.	84.	
Cartiers	100.	98.	L. E. Archais, Fayetteville, Ark.
Early Scarlet Turnip	40.	96.	
Early White Turnip Rooted	80.	63.	
New French Breakfast	48.	81.	
White Lady Finger	96.	87.	

CABBAGE SEED.

VARIETIES.	SEEDS GERMINATED		SEEDS FROM
	IN EARTH.	UNDER CLOTH.	
All Seasons	76.	49.	J. C. Vaughan, Chicago, Ill.
Bridgeport Late Drumhead	96.	82.	
Bucks Co. Flat Dutch	72.	52.	
Dark Red Dutch	72.	76.	
Denmark Drumhead	84.	67.	
Early Deep Head	72.	27.	
Early Etamples	76.	69.	
Early Jersey Wakefield	76.	74.	
Early Winningstadt	76.	69.	
Early York	68.	72.	
Extra Early Dark Red Erfurt	56.	42.	
Extra Early Express	92.	89.	
Extra Early Paris Savoy	76.	51.	
Filderkraut	92.		
Fottler's Imperial Brunswick Drumhead	92.	90.	
Henderson's Early Summer	80.	85.	
Large Late American Drumhead	80.	53.	
Luxumburg	84.	79.	
Marblehead Mm. Drumhead	84.	91.	
Marwin's Savoy	96.	92.	
Premium Flat Dutch	76.	89.	
Red Drumhead	60.	44.	
Select Early Jersey Wakefield	68.	62.	
Small Early Uhn Savoy	64.	32.	
Stone Mason	88.	97.	
Vaughan's Market Garden	76.	27.	
Warren's Improved	72.	81.	
Improved American Savoy	88.	67.	L. E. Archais, Fayetteville, Ark.
Premium Large Late Flat Dutch	80.	44.	
Large Early York	60.		
Early Jersey Wakefield	92.		
Fine Red Dutch Pickling	60.		
Earley Deep Head	32.		
Stone Mason	04.		
Bloomesdale Earley Drumhead	60.		Landreth. Rochester, N. Y.
Bloomesdale Early Market	52.		
Bloomesdale Large Late Flat Dutch	92.		
Earley York	16.		
Large Late Drumhead	88.		J. C. Vaughan, Chicago, Ill.
Cox's Early Spring	16.		
Louisville Drumhead	100.		
Fottler's Brunswick	64.		
Cassels	92.		

TOMATO SEED.

VARIETIES.	PER CENT. GERMINATED UNDER CLOTH.	SEEDS FROM
Advance	100.	Vaughan, Chicago, Ill.
Alpha	97.	
Canada Victor	90	
Cardinal	84.	
Dwarf Champion	90.	
Early Conquer	83.	
Essex Hybrid	97.	
Favorite	90.	
Golden Queen	100.	
Hathaway's Excelsior	90.	
King of the Earlies	90.	
Large Round Yellow	67.	
Livingston's Acme	90.	
Livingston's Beauty	90.	
Mayflower	90.	
New Peach	80.	
Optimus	87.	
Perfection	97.	
Paragon	90.	
Pear Shaped	53.	
Potato Leaf	100.	
Red Cherry	83.	
Red Current	93.	
Scoville's Hybrid	97.	
Trophy	73.	
Turner's Hybrid	90.	
Volunteer	97.	
White Apple	100.	
Yellow Plum	77.	
Haines No. 64	80.	Landreth. Rochester, N. Y.
Acme	70.	
Paragon	83.	
Trophy	90.	
Early Acme	53.	L. E. Archais.
Large Red	93.	
Livingston's Beauty	93.	
Livingston's Perfection	30.	
Livingston's Paragon	80.	

PEAS.

OPEN AIR SEED TESTS.

Twenty-five seeds of the following varieties were planted in the open air:

	PER CENT. GERMINATING.	SEEDS FROM.
Abundance	15	J. C. Vaughan, Chicago, Ill.
Alaska	72	
American Wonder	76	
Black Eyed Marrowfat	84	
Blue Peter	80	
Champion of England	80	
Daniel O'Rourke	52	
Dwarf Blue, Improved	88	
Ever Bearing	60	
Evolution	64	
First and Best	64	
Horsford's Market Garden	80	
Large White Marrowfat	48	
Lightning	88	
Little Gem	76	
Long Island Mammoth	48	
Maud S	76	
McLean's Advance	56	
Phil. Extra Early	48	
Pride of the Market	64	
Premium Gem	36	
Laxton's First of All	76	
Laxton's Alpha	60	
Tall Gray Sugar	72	
Telegraph	44	
Stratagem	84	
Yorkshire Hero	68	
Champion of England	44	LANDRETH, Rochester, N. Y.
Early May	76	
Irish Large White Marrowfat	68	
Landreth's Extra Early	64	
Phil. Extra Early	88	

BEANS.

VARIETY.	PER CENT. GERMINATING FIRST PLANTING.	PER CENT. GERMINATING SECOND PLANTING.	SEEDS FROM.
Black Wax	68	62	J. C. Vaughan.
Crystal White Wax	94	88	
Dwarf Golden Wax	64	70	
Dwarf Mont' D' Or'..	84	62	
Early Mohawk	98	92	
Emperor William	64	90	
Flageolet Wax	80	84	
Giant Red Eye		68	
Improved Valentine	64	56	
Perfection Wax	76	60	
Refugee	16	48	
Canada Wonder		72	
Long Yellow Six Weeks		78	
White Kidney	56	72	
White Marrowfat	84	68	
Wardwell's Dwf. Kid'y Wax		60	
Dwarf German Wax		82	Landreth. Philadelphia, Pa.
Red Speckled Valentine		74	
Early Yellow Six Weeks		82	
Early Mohawk		56	Ullathorne Co.
Valentine, Red Round Pod		70	

EXPERIMENTS WITH VEGETABLES

AT PINE BLUFF.

The object of experiments with vegetables has been to compare the relative earliness and productiveness of different varieties.

The land intended for vegetables was prepared in the following manner: Broken to a depth of six inches in January; in February it was top-dressed with stable manure and broken again, this time to a depth of about ten inches. Just before putting in the seeds or putting out the plants, whichever the case might be, the land was top-dressed with well-rotted farm yard manure, cotton seed meal and wood ashes, and the whole worked in with about two inches of the top soil, with a rake. All vegetables were planted in beds and cultivated with the hoe.

PEAS.

The following table gives the results of experiments with English Peas. They were picked at intervals of about three days and carefully weighed. Dry weather in the latter part of the season somewhat diminished the yield of late varieties. They

were planted February 13th, in rows fourteen feet long and two feet apart. A very good stand was secured by March 1st.

PEAS.

VARIETIES.	FIRST BLOOM.	FIRST MARKETABLE PODS.	LAST MARKETABLE PODS.	HEIGHT IN INCHES.	DAYS FROM PLANTING UNTIL FIRST PICKING.	DAYS IN BEARING.	YIELD IN OZS.	SEEDS FROM.
Abundance	Apr. 16	May 14	May 27	18	91	14	75½	Vaughan, Chicogo, Ill.
Alaska	" 5	April 22	" 31	12½	68	40	67½	
American Wonder	" 7	April 22	" 31	12	68	40	58½	
Black Eyed Marrowfat	" 19	May 10	" 27	48	87	18	102	
Blue Peter	" 7	April 25	" 31	15	71	37	49	
Champion of England	" 19	May 10	" 27	50	87	18	105	
Daniel O'Rourke	" 5	April 22	" 27	30	68	36	51	
Dwarf Blue Imperial	" 19	May 10	" 27	24	87	18	39½	
Ever Bearing	" 16	May 16	" 24	30	93	15	49½	
First and Best	" 5	April 22	" 31	30	68	40	77	
Horsf'd's Mark. Gard	" 12	May 10	" 27	24	87	18	65	
Large White Marro'fat	" 24	May 13	" 27	48	90	15	56	
Lightning	" 5	April 22	" 31	30	68	40	73½	
Little Gem	" 9	April 27	" 31	24	74	35	56½	
Long Island Mammoth	" 19	May 10	" 27	44	87	18	57½	
Maud S	" 5	April 22	" 31	30	68	40	39½	
McLean's Advance	" 15	May 10	" 27	24	87	18	59	
Phila. Extra Early	" 6	April 22	" 31	30	68	40	70	
Pride of the Market	" 21	May 13	" 27	24	90	15	40	
Premium Gem	" 9	April 27	" 31	24	74	35	76½	
Laxton's First of All	" 5	April 22	" 27	30	68	36	70	
Laxton's Alpha	" 7	April 27	" 27	30	74	31	56	
Stratagem	" 22	May 16	" 27	24	93	12	67	
Telegraph	" 21	May 10	" 27	44	87	18	65	
Tall Grey Sugar	" 25	May 16	" 27	54	93	12	79	
Yorkshire Hero	" 25	May 20	" 31	24	97	12	49	
*Champ. of England	" 18	May 16	" 31	30	93	16	63½	Landreth's.
†Early May	" 5	April 22	" 31	30	68	40	47½	
Irish Large White Marrowfat	" 27	May 16	" 24	48	93	9	39	
Londreth's Ex. Early	" 5	April 22	" 27	30	68	36	72½	
†Phila. Extra Early	" 7	April 25	" 31	30	71	37	43½	

*Champion of England received from Landreth is different from Champion of England received from Vaughan. The former is only about half as tall as the latter, and has larger pods.

†Early May and Philadelphia Extra Early, received from Landreth, seem to be mixed with a tall growing variety having very small pods.

BUSH BEANS.

Planted March 14th, in rows fourteen feet long and two feet apart. Yield reduced by dry weather in May. Seeds from J. C. Vaughan.

BEANS.

VARIETIES.	COLOR.	SHAPE.	FIRST MARKETABLE PODS.	LAST MARKETABLE PODS.	DAYS FROM PLANTING TILL FIRST PICKING.	DAYS IN BEARING	YIELD IN OZS.
Black Wax	Wax	Round	May 13	May 31	61	19	27
Crystal White Wax	"	"	" 26	June 7	74	13	40½
Dwarf Golden Wax	"	Flat	" 13	" 3	61	22	42
Dwarf Mont D'Or	"	Round	" 13	" 3	61	22	32
Emperor William	Green	Flat	" 13	" 3	61	22	81
Early Mohawk	"	"	" 13	" 3	61	22	90
Flageolet Wax	Wax	"	" 13	" 3	61	22	79
Improved Valentine	Green	Round	" 16	" 3	64	19	87
Lowe's Champion	"	Flat	" 13	May 31	61	19	36
New England Golden Cluster Wax	Wax	Round	" 20	June 3	68	15	42
Perfection Wax	"	Flat	" 13	May 31	61	19	4½
White Kidney	"	"	" 13	June 3	61	22	43

SECOND PLANTING OF BUSH BEANS.

Planted April 22d and 23d, in a bed nine feet wide, in rows eight feet long and two feet apart. When the beans were all up, each variety was thinned to an equal number of plants. Eighteen of each variety were left. The table gives total weight of beans picked from each variety.

VARIETIES.	COLOR.	SHAPE.	FIRST MARKETABLE PODS.	LAST MARKETABLE PODS.	DAYS FROM PLANTING TILL FIRST PICKING.	DAYS IN BEARING	YIELD IN OZS.
Black Wax	Green.	Round	June 11	June 29	51	19	28½
Canada Wonder	Green.	Flat	June 11	June 29	51	19	23½
Dwarf German Wax	Wax	Round	June 7	June 29	47	23	33
Dwarf Golden Wax	Wax	Flat	June 7	June 26	47	20	25
Dwarf Mont D'Or	Wax	Round	June 7	Juue 26	47	20	23½
Early Mohawk	Green.	Flat	June 7	June 29	47	23	27
*Early Mohawk.	Green.	Flat	June 7	June 29	47	23	33
Early Yellow Six Weeks	Green.	Flat	June 11	June 29	51	19	31
Emperor William	Green.	Flat	June 7	June 29	47	23	33
Giant Red Eye	Green.	Flat	June 11	June 29	51	19	27½
Golden Wax	Wax	Flat	June 7	June 26	47	20	25
Long Yellow Six Weeks	Green.	Flat	June 7	June 29	47	23	28½
Red Speckled Valentine	Green.	Round	June 11	Jnne 29	51	19	35
Perfection Wax	Wax	Flat	June 7	June 26	47	20	12½
Valent'e Red Ro'nd pod	Green.	Round	June 7	June 29	47	23	28
Wardwell's Dwarf Kidney Wax	Wax	Flat	June 7	June 29	47	23	28½
White Kidney	Wax	Flat	June 7	June 29	47	23	26½

*Seed from Ullathorne & Co.

A variety of beans sent for trial by Warthrop, Braslan & Goodwin Co. as a Dwarf Lima proved to be a pole bean.

TOMATOES.

The seeds were in the hot-bed on the 12th of February, and the plants set out in the open air March 27th. Two plants of each variety were used. The yield of each variety was taken up to July 15th. The average weight given in the table, is the average of all tomatoes gathered from the variety up to July 1st and from July 1st to July 15th.

	FIRST BLOOM.	FIRST RIPE.	YIELD TO JULY 1st IN OZS.	AVERAGE WT. IN OUNCES.	YIELD FROM JULY 1st to 15th IN OZS.	AVERAGE WT. IN OZS.	TOTAL YIELD IN OZS.	SEEDS FROM
Advance	April 30	June 18	135	3 7	169	3.3	304	J. C. Vaughans, Chicago, Ill.
Alpha	May 2	" 19	124	4.7	128	4.9	252	
Canada Victor	April 30	" 17	111	5.06	105	5.	216	
Cardinal	May 2	" 20	38	4.7	279	5.6	317	
Dwarf Champion	" 6	" 20	47	5.3	132	4.4	179	
Early Conqueror	" 6	" 17	137	4.1	200	4.3	337	
Essex Hybrid	" 1	" 19	52	5.83	298	5.5	350	
Favorite	" 4	" 17	42	5.85	203	6.3	245	
Golden Queen	" 7	" 18	47	7.83	217	6.7	264	
Hathaway's Excelsior	" 6	" 19	30	6.	135	4.5	165	
King of the Earlies	" 2	" 20	91	4.5	195	4.3	286	
Large Round Yellow	" 6	" 18	88	2.4	.....	....	.....	
Livingston's Beauty	" 6	" 19	33	6.7	149	6.77	182	
Mayflower	" 6	" 20	38	6.2	121	6.3	159	
New Peach	" 6	" 19	11	1.5	.....	....	.....	
New Prelude	April 27	" 15	102	2.	.....	....	.....	
Optimus	May 7	" 19	35	5.9	154	5.1	189	
Perfection	" 10	" 21	20	5.	63	4.8	83	
Paragon	" 2	" 18	39	6.5	194	5.7	233	
Pear Shaped	April 30	" 20	....	....	.....	....	.....	
Potato Leaf	May 2	" 20	43	4.7	98	4.6	141	
Scoville's Hybrid	April 30	" 17	65	6.4	166	6.6	231	
Trophy	May 7	" 24	37	9.3	135	9.	172	
Turner's Hybrid	" 9	" 20	24	6.	105	5.	129	

The above table is valuable mainly on account of its bearing on the relative earliness of different varieties.

Up to July 1st the varieties giving best yields were, Early Conqueror, Advance, Alpha, Canada Victor, New Prelude and King of the Earlie's, coming in the order numed.

From July 1st to 15th, the varieties giving best yields in

order named were, Essex‖Hybrid, Cardinal, Golden Queen, Favorite and Early Conqueror.

RADISH.

The object of these experiments was to compare relative earliness, and ascertain the length of time that each variety remained fit for table use. Each variety was marked ready for the table, as soon as a radish could be found large enough to be put on the market; and as soon as one pithy radish could be found, the variety was marked pithy. Seeds were sown March 13th, by the 20th, a very good stand of all varieties were up.

VARIETY.	READY FOR TABLE USE.	PITHY.	SEED FROM
China Rose Winter	April 22	May 24	J. C. Vaughan, Chicago, Ill.
Chinese Mammoth Winter	" 22	" 24	
Extra Early Scarlet Globe	" 12	April 16	
Earliest Carmine Erfurt	" 12	" 16	
Early Scarlet Turnip	" 12	" 22	
Early Deep Scarlet Turnip	" 12	" 16	
Early White Giant Stuttgart	" 22	May 21	
French Breakfast	" 12	April 16	
Golden Yellow Summer Turnip	" 15	May 9	
Grey Summer Turnip	" 15	" 1	
Improved Chartiers	" 15	April 27	
Half Long Deep Scarlet	" 12	" 16	
Yellow Summer Turnip	" 17	May 9	
Long White Naples	" 10	April 22	
Long Black Spanish	May 1	July 6	
Long White Vienna	April 18	May 1	
Long Scarlet Short Top	" 15	April 19	
Olive Shaped White	" 15	" 19	
Olive Shaped Deep Scarlet	" 12	" 16	
Round Black Spanish	" 22	June 13	
Scarlet China Winter	" 18	May 9	
Scarlet Turnip, Non Plus Ultra	" 12	April 16	
Scarlet Turnip Whtte Tipped	" 12	" 22	
Shepherd	" 18	May 4	
Vaughan's Olive Shaped	" 12	April 16	
White Strasburg	" 17	May 4	
White Turnip	" 15	" 1	
Woods Early Frame	" 15	April 19	

The "Golden Yellow Summer Turnip," and Yellow Summer

Turnip are identical. The "Early Scarlet Turnip" and the "Scarlet Turnip White Tipped" are as early as any of the early varieties and remain firm much longer. They are both valuable on account of earliness and the length of time they are fit for table use.

CABBAGE.

The seeds were sown in a hot-bed on the 11th of February, and plants set out on March 22d and 23d. On account of limited space the plants were set in rows two feet apart, and eighteen inches apart in the row. Six plants of each variety was used. The soil was a sandy loam, but not well adapted to cabbage on account of insufficient drainage. Late setting out and repeated heavy rains delayed heading.

On April 6th a second set of experiments similar to the first were begun, the only difference between the two sets being, that four plants of each variety were used in the second experiment instead of six.

These experiments are valuable on account of their bearing on the relative hardiness of different varieties, and as indicating the varieties that will give the largest per cent. of heads under adverse conditions.

The experiments were not begun early enough to give the early varieties a fair showing; and the late transplanting probably accounts for the small per cent. of heads among the early varieties.

VARIETIES.	PER CENT. OF HEADS IN	
	FIRST EXPERIMENT.	SECOND EXPERIMENT.
All Seasons	100	100
Bridgeport Late Drumhead	83⅓	25
Bucks Co. Flat Dutch	00	75
Dark Red Dutch	33⅓	00
Denmark Drumhead	100	50
Early Deep Head	33⅓	25
Early Etampes	33⅓	00
Jersey Wakefield	50	75
Extra Early Dark Red Erfurt	83⅓	100
Extra Early Express	33⅓	00
Extra Early Paris Savoy	50	00
Fielder Kraut	50	25
Fottler's Improved American Drumhead	33⅓	50
Henderson's Early Summer	33⅓	75
Late Large Autumn Drumhead	16⅔	00
Luxemburg	50	75
Marblehead Mammoth Drumhead	00	00
Marwin's Savoy	50	25
Premium Flat Dutch	83⅓	00
Red Drumhead	50	00
Small Early Mammoth Savoy	00	00
Stone Mason	50	75
Vaughan's Market	66⅔	25
Warrens Improved	83⅓	25
Improved American Savoy	00	00
Landreth's Earliest	66⅔	75
Louisville Drumhead	33⅓	50
Fottlers Brunswick	83⅓	00

CAULIFLOWER.

Two parallel sets of experiments were conducted similar in time of sowing seed, time of transplanting, and in the number of plants used.

Of the twelve varieties tested, two in each set of experiments gave very fair heads; the other varieties made no heads.

The two varieties giving heads were the Extra Early Erfurt and Henderson's Early Snowball.

CELERY.

Five varieties of celery were tested. All promised well at first, but during the hot, rainy weather in June the plants became affected with a blight which killed the leaves and prevented further growth.

The celery was planted on a level piece of ground, in rows three and one-half feet apart and six inches apart in the row.

The experiments will be continued another year and the effect of trenching and shading tested.

SQUASHES.

Three varieties were tested; of these the Chicago Orange Marrow was the earliest, but was not very prolific; this squash is largest in the middle and tapers uniformly to the ends. It is a summer variety.

The Summer Crookneck is nearly as early as the above. It is a small and very prolific variety.

The Bay State is a large and very prolific variety. It is a more vigorous grower than the above varieties, is squarely cut off at the ends.

PUMPKINS.

One hill of the mammoth $50 Pumpkins was planted. It produced two pumpkins weighing respectively ninety-eight and sixty pounds.

Another hill was planted on the 9th of August, but the pumpkins did not have time to mature before frost. When the vines were killed by frost there were eight immature pumpkins, weighing from eighteen to twenty-one pounds each.

VETERINARIAN'S REPORT.

During the year, the following contagious or endemic diseases of domesticated animals have been met with in this State: Glanders, Suppurative Fever and "Charbon" in horses and mules. Actinomycosis, Pasture Poisoning, Murrain, Texas Fever and Liver Rot in Cattle, and Intestinal Parasitism in sheep.

A brief note of the extent of each, and the conditions under which it occurred may be of use in assisting in the recognition of such cases in the future, and to some extent indicating the most necessary measures of suppression or prevention to be employed by the owner himself in default of proper professional advice and treatment

In the first place, where trained professional services can be obtained (which, however, is extremely rare in this State) the employment of such is always the most economical.

Where this is not available, the judgment and common sense of the owner must hold the next place; either of these attributes being superior to the qualifications of the local wise-acre in animal diseases, whose tail-splitting and horn-boring testify no less to his own ignorance than to the credulity of his patrons. Non-interference is always preferable to empericism, even when backed up by mysterious looks and voluble verbosity. Careful nursing and diet in ordinary cases affords a better guarantee for recovery than the indiscriminate employment of drugs. In the case of communicable diseases early separation and isolation are essential to their suppression.

Glanders—This contagious disease of horses and mules has been met with in two or three districts, and reported from others. In most cases the measures recommended, namely, slaughter of affected animals, vacation and thorough cleaning and disinfection of stables and quarantine of exposed animals

were adopted with successful results. The disease is well known by name to horsemen, but its positive identification is sometimes difficult. In the chronic form, which is most common, it often simulates closely to chronic catarrh. The characteristic symptom of glanders, distinguishing it from ordinary catarrhal inflammation, is the appearance of the nasal septum, which, in typical cases, shows irregular, pit like ulcers. Sometimes, however, these do not occur on the parts exposed to view, and these are the cases which are the most dangerous from being unsuspected. The other symptoms, unthrift, gleety nasal discharge, cough, hardened and enlarged glands beneath the jaw are not peculiar to glanders, but may accompany simple catarrh. The identification of glanders by the specific gravity of the nasal discharge, that is, whether it sinks in water or floats on the surface, is a delusion. In all cases of long standing complaint of this nature, especially if several are similarly affected in one stable, the proper plan is to isolate such cases until satisfied as to their true nature.

Suppurative Fever or distemper of horses, which seems one of the necessary evils of colt life, has not been reported as prevailing in a malignant form, such as occurred in some districts last year. Its symptoms and treatment were detailed in the last report, and do not require repetition here.

"*Charbon*" is the local name applied to a disease which prevails during some years in the southern parts of this State, especially in the low bottoms. It attacks horses and mules. According to reports, the loss from this disease is sometimes very great. My knowledge of this complaint is entirely hearsay, as no well marked cases have come under observation. It seems to be a sort of malignant œdema, originating without visible cause, usually first appearing on the under surface of the abdomen or breast, and extending forward until the whole head and neck becomes involved. The termination is fatal in a variable period. It is doubtfully contagious, but sometimes appears in an endemic form, that is, affecting many animals in one district at the same time. As before said, I have not yet had the opportunity of investigating or identifying this disease,

but whatever its nature, there is no doubt that the name, "Charbon," is inappropriately applied, that being a well-known disease of ruminants, chiefly, but not exclusively. Hearing of an extensive outbreak at Yazoo, Mississippi, I prepared to go there and satisfy myself of its nature, when I was informed that the Veterinarian for that State was already on hand. We may, therefore, expect to hear shortly something on the subject from that quarter.

DISEASES OF CATTLE.

Actinomycosis, or lump jaw, as I have seen it, occurs in this region in the form of enlargements, or tumors in the region of the neck, throat and face as well as beneath the jaws. They sometimes grow at first with considerable rapidity, afterwards becoming stationary in size or, slowly increasing. Sometimes they are multiple, and sometimes single. After usually a considerable time, matter forms in the centre which in time gains exit by ulceration of the skin covering the tumors. The importance of this disease is chiefly referable to its specific cause which has been shown to be a fungus. On this account the disease is regarded as communicable, and cattle so affected are condemned from exposure on the market in some cities. The fungus from its form is readily recognizable, and has been found in the human being, causing fatal complications in internal organs. The full history and classification of the parasites are as yet unknown; nor is it known how it obtains access to the situation where found. Cultivation of the fungus on artificial media outside the body has not been successful in my hands, nor have I succeeded in producing the disease in healthy animals by inoculation. However, this has been claimed to have been accomplished by others, and this being the case, isolation of such animals is indicated. As it is not impossible that the udder may be affected, although not showing it externally, rejection of the milk is also judicious. By way of treatment, mercurial blisters may be tried in early stages, or excision by surgical operation. When pus forms evacuation and injection of strong germicide solutions daily may succeed.

Noxious weeds or grasses. Although I have not had the opportunity of investigating this subject, I am led to believe from reports received, that cattle especially do, in certains seasons and districts die from consumption of poisonous plants. This seems to occur chiefly from grazing in woodland pastures.

A fatal outbreak of disease in cattle occurred near Brentwood, in May, causing the loss of a considerable number. It was believed to be contagious, but on visiting the district I could find no evidence of this. The most prominent symptoms purging, and evident narcotism, rather indicating the presence in the woods in which the cattle were pasturing, of some poisonous vegetation. What the plant was I could not determine.

"*Murrain.*" It seems appropriate here to make some mention of the use of this term in animal pathology. Reports are not infrequently received at this Station, of cattle dying in different parts of the State from this disease.

On investigating such cases, or where the symptoms have been described, it is found that this name is popularly used for almost every disease to which cattle are subject. As a distinguishing term, therefore, the word has no significance. Many of the cases of "Murrain," which seem to be so common further south in this State, are doubtless really cases of Texas Fever. This will be referred to again.

Parasitism in Sheep. Under this head mention will be made of one form of parasitism which, so far as I can learn, has never been referred to in our works on this subject. From personal observation and information obtained from butchers, I conclude that the condition is quite common in sheep of this State. The following transcript of notes taken when examining the first cases seen will give an idea of the condition of the intestine.

Dec. 12, 1888. A sheep about eight months old, raised on College farm, healthy, and killed for food, contained throughout the whole lenghth of the intestine from stomach to rectum, in its walls small nodules from the size of a pins head, to that of a small bean. They were scattered over every side of the wall, varying in numbers in different parts; in places as

many as twenty within six or eight inches length of intestine. These nodules showed most prominently on the serous side, but their capsule seemed thinnest on the mucous, or internal surface. The contents were generally green, or in some dark, cheesy consistence, and in darker ones gritty, as if from commencing calcification. By making a small cut on the outer surface the contents could be squeezed out of its capsule. It could often be squeezed out on the inner surface without cutting, being forced through small pores, one or more of which in some cases could be seen on the summit of the nodule. The green contents, when tested, yielded 2.8 per cent. of fatty matter. Examined microscopically it seemed largely granular debris without definite structure. No worms could be detected in the capsule, or intestinal contents.

Dec. 19. Another sheep of the same age was killed and found similarily affected, while a few cysts were also found in one lobe of the lung. All the other organs seemed healthy. When these nodules were hardened in alcohol and cut for microscopical examination, they showed the capsule to be composed of fibrous tissue, while the contents presented no structure whatever. There is little doubt but these are the old nests of some form of Helminth, or parasitic worm. The same condition has been observed frequently during the past year, but in no case was the parasite found. The supposition is that residence within these cysts in the intestinal wall of the sheep constitutes part of the life history of some as yet undiscovered parasitic worm, and that that phase of its existence having passed, it leaves its cyst to continue its further existence externally or in some other host. All the specimens so far examined seem to be those in which the parasite had already escaped. The importance of this form of parasitism can not be determined until the life history of the parasite is discovered. It seems not to interfere with the health of the sheep.

"Liver Rot" of Cattle—In this paper will be given an account of an investigation made during last summer on an abnormal condition of the livers of cattle raised in certain region of the State. It had been previously reported to me from va-

rious sources that the livers of all, or nearly all cattle slaughtered in that part of the State were unfit for use, and had been so for years. As these districts corresponded to, or rather, were embraced in what is known as the region of permanent infection of Southern or Texas Cattle Fever, and as the liver is one of the organs most evidently affected in this disease, it was naturally supposed that this might be the result of a non-fatal attack of Texas Fever, to which, as some pathologists assert, and I believe, correctly, Southern cattle are subject.

The place selected for a Sub-Station for certain experiments in Texas Fever, namely, Helena, in Philips County, was, fortunately, favorably situated for investigating this liver disease as well, and the conclusions arrived at were all deduced from observations made while attending the slaughtering houses in that town. The first case examined was sufficient to show that this diseased condition of the liver had no connection with Texas fever, but that it was a form of disease popularly known (in countries where it is common,) as "Liver Rot," and due to the invasion of the liver by a parasitic worm. As this was a typical case, a transcription of notes taken at the time will give a fair idea of the appearance presented by the liver in this disease:

June 12th. Steer four years old; came from St. Francis county, apparently in good health and fair butchering condition. The "fat caul" seen on first opening the abdomen, as a large sheet, was dotted with black spots and streaks. Lymphatic glands on the concave surface of the liver were much swollen and black in color. The liver itself was enlarged and darkened on the surface, with a number of prominent elevations, some appearing like blisters, and some more or less solid and varying greatly in size. A longitudinal section showed the presence of many cavities, some containing a dark, solid substance, while other contained a dark brown fluid in which were floating granules and shreds of tissue. One very large cavity, about two inches in diameter, with irregular, yellowish colored walls, besides the dark colored fluid above mentioned, contained also two flat, leaf-like bodies about one inch in length

and slightly less in breadth. They were fished out and recognized as "Flukes," a variety of parasitic worm to be described further on in this paper. More of these were obtained from other cavities. Several small cavities contained solid, greenish, yellow, gritty matter and no parasites. A section made through the liver in any direction, cut through one or more of these cysts. They were situated near the surface of the organ or in its substance indiscriminately. Those that contained the "Fluke" were usually of medium or smaller size, and the parasite was found folded or curled upon itself longitudinally and surrounded by fluid. When taken out carefully and placed on the table, they usually exhibited slight contractile movements. This evidence of vitality soon ceased, except when they were kept in the same medium in which they were found in the liver, when life could be maintained for over twenty-four hours. Some were evidently dead when extracted. The shreds of tissue found in those cysts, which did not contain the living parasites, were shown by microscopic examination to be the debris of dead and partly decomposed Flukes.

Such were the gross appearances of the livers of at least three fourths of the cattle slaughtered during the spring and summer at this place, and of about ninety per cent of all cattle coming from certain ranges in St. Francis and Lee Counties.

Some livers and these, became more common as the summer advanced, did not contain any living flukes, but on section showed cicatrices or scars the evidence of former inflammatory action, with some cavities containing dried up solid contents. Towards the months of August and September this was the common condition, no living flukes being found, and this change is important as giving us some idea of the life history of the parasite as will be seen later. So far as could be seen the cysts in the liver were in communication with the smaller bile ducts only. The main biliary duct was not evidently diseased, whilst the bile contained in the gall bladder was sometimes of normal appearance, and sometimes in bad cases, of dark color, thick and grumous.

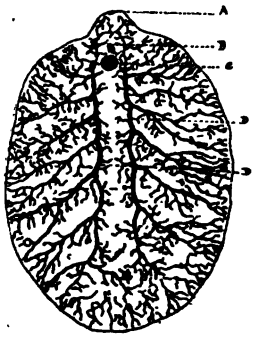
Microscopic examination of portions of these livers showed

the usual appearances of chronic inflammatory action. The connective tissue was thickened, and hypertrophied throughout. Inflammatory tissue surrounded the cavities with commencing calcification in the walls of those of older formation. The fluid contents of some of these cysts contained numerous eggs of the flukes. These were in some instances found also in the bile, and contents of intestine. The natural appearance of the bile, even in cases in which the liver seemed extensively diseased, would seem to show that this organ still retained to some extent at least its functional powers. In badly diseased livers, as many as forty to fifty flukes were found, whilst others contained not more than two or three. Some did not contain any living parasites, but showed well marked evidence of their former presence. Such livers were harder than normal, and uneven and discolored on the surface, whilst on section they showed bands of greyish white cicatricial tissue with here and there contracted cavities with hard cartilaginous walls and solid contents. With the exception of the "Fat Caul," before mentioned, and the glands in the neighborhood of the liver, the other organs were healthy in appearance. Before death there were no positive symptoms by which this disease could be detected, but it was noticed that those cattle whose livers were badly diseased, were never in very good butchering condition.

Discription of Fluke—This report is no place for a scientific description, but, a brief outline of the anatomy, place in the animal kingdom, and life history of the parasite, may not be without interest to some readers.

The *Fasciola Hepatica* or Liver Fluke (so called from its leaf like form) belongs to the sub-kingdom *vermes*, (worms) and order *Trematoda*.

The specimens obtained during last summer differ somewhat from the description and figures usually given of this parasite. The accompanying figures shows its appearance when cleared up by immersion in oil of cloves, and viewed by transmitted light.



The average length is about one inch, and breadth three quarters of an inch; flat on both surfaces, and thin on the edges. The color is a dark brown like the fluid in which it is found. At the anterior extremity is an opening (*a*), the oral sucker which leads into the intestinal system. This, which forms the great mass of the body consists of two main branches traversing the body longitudinally on each side (*dd*) of the middle line, and giving off branches which again divide until they alternately terminate in blind extremities either on the margin or in the substance of the body. Behind the oral sucker, on the ventral surface, is another larger opening, the ventral sucker(*b*,) and in front of this a little prominent papilla (*c*) in which is the opening of the common tube lead ing from the reproductive organs, and through which the eggs escape. This is all that can be seen (See Figure) by ordinary methods of examination. Serial sections show under the microscope the presence of the reproductive organs, male and female in the same individual, ranged on either side the median line, and in the adult fluke eggs more or less developed and ready for extrusion. The eggs were frequently found in the fluid with which the fluke is surrounded in the liver.

Life History—The complete life history of the Fasciola Hepatica has not yet been traced out, but Cobbold, whose writings constitute our chief authority on Entozoa, believes the following conclusions to be well founded.

The liver Fluke, in its sexually mature state, is the cause of the disease, commonly called *rot.*

Rot is especially prevalent during spring, at which time flukes and free eggs are both passed off with the faeces of affected animals and dropped on open pastures. One diseased animal may be the means of distributing millions of eggs. These eggs are scattered over the pastures and often carried to considerable distances by natural agencies, rains, winds, feet of animals, etc., and ultimately sôme of them find their way

into water, running or stagnant, in which alone, they are capable of undergoing further development. Here they are hatched, and after passing through several phases of existence, during one of which, at least, they are parasitic, inhabiting the body of some species of aquatic animal, they are finally taken into the stomach of their ultimate bearer in drinking, or possibly in grazing on infected pastures. They pass into the intestine, and thence up the bile duct to the liver, where they develop into the adult form, capable of bearing eggs, and thus reproducing their kind.

The most common bearers of the Liver Fluke are the sheep and ox, but it has been found in many other animals. It is only when the parasites exist in the liver in large numbers that they give rise to fatal disease. No excessive losses from this cause have occurred in America; this, so far as I can learn, being the first instance reported of its extensive occurrence among cattle. In European countries and in Australia on the other hand, "Liver Rot" has at times proved one of the most serious scourges which the sheep raiser has to contend against, sheep being always more seriously affected than cattle. A knowledge of the complete life history of the fluke and its intermediary bearers, that is, the period which elapses and changes, which the embryo undergoes between its exit from the body of its host in the form of an egg and its re-entrance to attain its sexually mature form in its new host, would supply us with the only scientific basis upon which positive preventive measures against the ravages of "Liver Rot" can be confidently grounded. This knowledge we do not yet possess, but what we do know is not without its value in this respect.

One condition essential to the hatching of the eggs is moisture, and this is shown in our experience of the disease which is most extensive during wet seasons or a succession of such, and in parts of the country where the soil is devoid of natural drainage, subject to overflow, or which contains many stagnant ponds of water. This is the condition of the ranges in St. Francis and Lee counties where the disease prevails in this State. The eggs are for the most part deposited on the pastures in

spring and early summer, and it is most probable that the remainder of the summer is required for the completion of the non-parasitic life of the embryo, at least so far as its alternate host is concerned. We have no evidence to show that ingestion of the embryo during this time would be followed by its further development in the liver of ruminants. The habits of entozoa in general, and the fact of the prevalence of the disease in spring and early summer, and its rarity in fall and winter indicate it is only during a limited portion of the year that infected pastures and ponds are dangerous. This period is probably, late in the fall and early in winter, the winter being spent in attaining its full development in the liver. After attaining its mature form and bearing eggs the parasite dies, either being expelled with the faeces, or remaining in its cyst, and decomposing there, helping to form the solid matter with which old cysts are filled, the eggs meanwhile being set free and expelled with the bile into the intestine.

Prevention and Treatment—As before said the extent of Liver Rot is largely dependent on climatic and tellurial influences warm moist weather, and undrained and uncultivated soils being especially favorable to its extension. The prevalence of the disease may be considered as a measure of the degree of infection of the pastures, modified to some extent, doubtless, by the previous condition of the stock, animals otherwise in poor condition being especially liable to the attacks of parasites of all kinds.

As the embryo fluke doubtless passes the winter within the body of its host, the character of this season, mild or otherwise, has probably little influence in either extending or limiting the disease. Embryos which fail to find a suitable host perish in any case.

But for unfavorable influences, the most important of which is the occurrence of one or more dry seasons, (spring and summer) the pastures would tend to become further infected from year to year, Increase in the number of cattle or sheep grazing on such pastures will tend to their further infection and vice versa. Movement of cattle, especially in the

spring of the year, will of course, under favorable condition lead to infection of pastures hitherto harmless. That such extention has not taken place in this instance is due to the fact that cattle are rarely shipped from these ranges except for immediate slaughter for beef.

As to the qnestion whether or not the disease is likely to die out of its own accord, both experience and science lead us to think that it will not, but, while subject to remissions aud exexacerbations according to season as above explained, the presumption is that as these ranges become further stocked the infection will correspondingly increase both in degree and in extent.

As before said, sheep are much more seriously affected by the invasions of this parasite than cattle. In this investigation I have been unable to find out to what extent the disease prevails among these animals for the reason that very few are kept in these parts, and none found their way to the slaughtering pens at Helena, where my observations were chiefly made. We may safely predict that if sheep breeding should ever be largely engaged in in that district the result would be disastrous, and this suggestion we advance for the benefit of those concerned.

In view of the fact that sheep and cattle are the most common bearers of the adult form of this parasite, the idea will doubtless occur to the reader that a ready means of radically purifying these pastures would be to completely exclude these animals from grazing there during one season, when for lack of the necessary conditions for its development, the source of infection would necessarily perish. This suggestion is not without value, and if we were certain that sheep and cattle were the only bearers or hosts of the adult fluke, would certainly be effective.

Dr. Rowe however, speaking of the disease as it occurs in Australia asserts that he "Found the common Liver Fluke in sheep, cattle, goats, opossums, kangaroos, geese, ducks and other creatures." This being the case it is not improbable that the germs of infection in the region which now concerns us may

be kept alive and propagated by finding a suitable habitat in the liver of rabbits and some varieties of wild fowl which are found there. This possible contingency would invalidate any assertion of the absolute purification of the infected ranges by the exclusion of sheep and cattle; but such exclusion, even if not completely effectual, would undoubtedly tend very considerably to the mitigation of the disease. As a practieal measure of prevention, therefore, it is recommended that stock-breeders in the infected districts, for one season at least, remove all their cattle to the dryest part of the farm in the fall and early winter and water them from wells exclusively. Among other means of prevention, one which was much advocated in Australia, is the burning of pastures. This is not an uncommon accidental occurrence in the cattle ranges of this State, but the season of the year in which it occurs, namely in fall, is not that which would be most favorable to the destruction of the eggs of the liver Fluke. This ought to be in spring before the embryos have begun their aquatic existence. Occasional accidental burning of pastures, however, no doubt does tend to the mitigation of the disease.

Another extremely practical measure of prevention founded both on scientific observation and practical experience is the frequent use of common salt as an article of diet. Cattle and sheep that are pastured on the sea-coast or on salt water marshes never suffer from this dfsease. Scientific observation has shown that the slightest admixture of common salt prevents the development of the Fluke egg and embryo. Therefore for those who are disinclined to adopt the more radical measures referred to above, this liberal use of salt, necessary even under ordinary circumstances in pastures so far removed from the sea-coast, is confidently recommended both as a preventive and a curative agent.

Where the disease is thoroughly established, however, no effective treatment except sustaining of the system by nutritive diet can be recommended. From enquiries I learn that this disease has existed in the region around Brinkley for some five

or six years and that it is gradually increasing in extent and severity.

Influence of the Disease on the health of Cattle.—On this question the opinions of cattle raisers and buyers seem to differ widely, some asserting that such cattle are in as good health and fatten as well as those from any other district, while others look upon them with suspicion and say that neither whilst living nor upon butchering do they make a satisfactory show.

There is no direct evidence to show that cattle on these ranges ever die from the disease, but death of cattle from some cause, as, I am informed, is not uncommon there, and it is not at all unlikely that many of such cases may be due to liver rot. The almost complete destruction of the liver in many cases examined would certainly lead one to think that in time the health and digestive capabilities of the animal must be seriously impaired, and there is little reason to doubt that the value of these ranges, otherwise eminently suited for cattle raising, is much deteriorated by the prevalence of this pest.

As regards the Consumer.—The question naturally arises, what influence has this disease on the flesh of the animal as an article of diet? On examination after death we find that, however much of the liver may be affected, the other organs are apparently healthy, and this statement in general applies also to the flesh. The Fluke itself has never been found in cattle in any other organ except the liver, which is its natural abode. The possibility of man becoming similarly affected by consumption, even of a diseased liver, need not be entertained; the knowledge we possess of the conditions necessary for the development of the embryo in the outer world precluding such an idea. Cases have been reported in which both the larval and the adult form of the fluke have been found in the human system, but these are extremely rare, and not at all connected with the consumption of diseased flesh. It is hardly necessary to say that, although it can not be a source of Fluke infection to the consumer, a diseased liver is nevertheless both an unpalatable and

unsafe article of diet. In general the flesh may be considered as perfectly wholesome, except in very bad cases in which the health and constitution are evidently impaired, and such animals by their emaciation would condemn themselves. As a rule, it may be said that, so far as liver rot is concerned, when an animal is in a condition evidently suitable for butchering, the flesh may be considered suitable for food. In concluding this subject I quote the following opinion of Dr. Cobbold, our principal authority on Helminthology.

"On the whole I think we may agree in regarding the consumption of the flesh of rot-affected animals as free from danger provided only the meat be well or even moderately well cooked.

It must be borne in mind, however, that an essential objection to its consumption lies in the fact that the watery and otherwise chemically deteriorated flesh is comparatively innutritious. It must also be noticed that the meat supply from fluke-affected animals, as usually sold in the markets, is chiefly derived from animals which have only entered the early stage of the disorder, that is, long before the watery and wasted condition of the muscles has fairly set in."

Tuberculosis—In this connection when the subject of Tuberculosis and its propagation to man by consumption of beef is so rampant in literature, we may be allowed to remark that although a very large number of cattle were examined in an almost daily attendance at the slaughtering pens during last summer and fall, no cases of this disease were discovered. The freedom of our cattle from this disease, contrasted with its reported prevalence in the eastern feeding and dairy stables, must be chiefly ascribed to the manner in which they are raised, and possibly also to the inherent hardiness of the native stock.

SOUTHERN CATTLE FEVER.

In the last annual report of this Station the disease of cattle commonly known as Texas, or Southern Cattle Fever was discussed at some length, and the most important points necessary to a general understanding of its nature were referred to. The literature of this subject has been somewhat increased lately by

scientific investigation and some very suggestive theories founded thereon. On this subject, however, as on most other subjects of the same kind, theories have always been more plentiful than well proven facts. Experiments have been begun by the Veterinary Department of the Experiment Station of Missouri, in conjunction with this station and that of Texas, with the object of clearing up some of the uncertain points in connection with the disease. These experiments will be continued until definite results have been attained. In this paper we propose merely to give the lines along which these experiments are being conducted, the objects to be attained, and to report the progress which has so far been made. The experiments are under the direction of Prof. Paquin, of Missouri, a scientist who is eminently qualified for such work and has had much practical experience with Texas Fever. His report of the present year's work has not yet been published and therefore it is impossible, as yet, to correctly estimate the value of the experiments or deduce any conclusions therefrom.

It is expected that in a future bulletin, based on the conjoined reports of the different States concerned, a full record will be given of these experiments and their results.

In order to give a correct understanding of the object of this work it will be necessary to review briefly some of the most essential facts that are already known of Texas Fever. The name "Texas Fever," although misapplied, is used in this report because it is by that name that the disease is most generally known in this state. It is known then that cattle shipped from northern parts of this country or from foreign countries to the Southern States or at least some of the Southern States, are liable to die during their first summer in their new home; the per centage of deaths varying in different localities, but generally being extremely high. The parts of the country thus dangerous to imported northern cattle are regarded as permanently infected with the germs of Texas fever, and are bounded on the north by a very irregular East and West line. Part of this state is permanently infected, and part of it free from infection. Again, it is equally well known that cattle apparently healthy, shipped

from these southern parts to Northern States infect the pastures there where they graze, and thus, indirectly, infect northern cattle in whom the disease is extremely fatal. Thus, a herd of cattle from the south may be observed on northern pastures healthy and thriving, whilst the native northern stock are dying on every side of them, and dying from the infection of the pastures by the former. This is a fact that the average southern stock breeder, even at this late day, finds difficulty in understanding or crediting. He may be excused for not understanding it, but the fact is too well authenticated to admit of disbelief.

Droppings from stock cars containing Southern cattle also

The paper intended for use on this Report was burned with the Steamer DeSoto, on the Mississippi; to this misfortune should be ascribed the varying shades of paper used, and not to any lack of care on the part of printers or publishers.

MITCHELL & BETTIS.

Little Rock, Feb. 15, 1890.

authenticated cases in which this has been shown to occur. According to that investigator, the germs of Texas fever, are so weakened in virulence by passing through the intestines of cattle that they require a lengthened period of growth in the outer world on the pastures before they again acquire the power of causing disease in cattle which ingest them, and this period from six weeks to two months has usually been found to elapse between the time of the arrival of Southern cattle on northern pastures, and the first outbreak of disease. Another much disputed question is whether or not Texas fever ever occurs among Southern cattle which inhabit the permanently infected regions, and if so, whether it ever proves fatal. This is not such an easy point to determine as might appear. The symp-

toms of the disease, especially when it occurs in a mild form, are not very characteristic, and, even in fatal cases, the post-mortem appearances are not always uniform. During residence in an infected district last summer I endeavored to satisfy myself on this question as to the complete immunity of Southern cattle On inquiry I was informed that the native cattle quite frequently die from some disease the symptoms of which as described, correspond more or less with those of Texas fever, but which is locally known as "Murrain," and that a large number had died during the fall preceeding in the neighborhood of Helena. What was the cause of this last outbreak it is impossible to say, but I had the opportunity of proving by examination after death, that at least some of the cattle native to that place die from Texas fever. This, however, does not settle the question as I found that such deaths usually occur in cattle which have been moved into town from some distance in the country. It is well known to all cattle owners there that during summer and fall movement of cattle from certain parts of the surrounding country, and even from a distance of a few miles, into the town, or its immediate neighborhood, is liable to be followed by their death. The same thing happens when cattle are brought from over the river in Mississippi. As these cattle undoubtedly die from Texas fever we must conclude that they come from parts that are not infected. I am inclined to believe from these and other observations that the infection of southern pastures is not so universal as usually supposed; that in this State, at least, there are tracts of country the pastures of which are as yet pure whilst surrounded by infected regions.

As to whether the opposite condition has been fullfilled, that is, death of cattle on these pastures removed from town by movement of town cattle there I have no information. In view of these facts the deaths from Texas fever occurring occasionally around Helena can not be considered as proof of the statement that Southern cattle in the infected regions do occasionally die from this disease. Although the pastures in the vicinity of that town are, as we shall see, polluted by the infection in its most virulent form, the fact of the surrounding coun-

try in many parts being free from infection makes this location unsuitable for determining with accuracy this important question. Althouth other considerations and reports from districts further south incline me to the belief that Southern cattle do become affected. I can not so far positively affirm that such is the case. This question is important in its bearing on the possibility of preventive inoculation of Northern cattle—one of the principal objects aimed at in these experiments.

Cause of Immunity in Southern Cattle—Whether Southern cattle suffer from Texas Fever or not, it is certain that, as compared with imported Northern stock, they suffer to a very limited extent, and the question arises, whence is this immunity derived? The usual answer to this is, that these cattle being raised on infected grounds, constantly take in the germs of the disease with their food and water, and thus gradually becomfng accustomed to their action are able to withstand it, just as the continuous use of certain poisonous drugs in time renders the human subject proof against doses which would otherwise prove fatal. This theory does not necessarily infer that the subjects ever really become diseased; that is, that the germs ever pass the stomach and intestines, and multiply in the blood and internal organs. The production of immunity in this way, merely by living in an infected region for a lengthened period without at any time becoming affected, is not very well established, even in the case of human infectious diseases. The most certain means by which immunity is obtained from any non-recurrent infectious disease is through the influence of a first attack, and this is probably the explanation of the fact that Southern cattle live in safety on these infected pastures. It is on this basis also that the theory of preventive inoculation is founded. Young calves, as is well known, may be brought to the Southern States from the North with much less danger than older animals. Either they are less susceptible to the action of the virus, or if suckling, receive it at first in smaller doses, thus becoming gradually habituated to it, or by undergoing a mild attack receive from this future protection. This will apply also to newly born calves in the South which in this respect are in the same condition

as imported Northern animals, except that as is not unlikely a certain degree of their immunity may be inherited.

Whether one mild attack of Texas Fever is sufficient to confer permanent immunity, or whether these Southern cattle suffer from repeated mild attacks or not we do not know. Even infectious diseases which are regarded as non-recurrent are not absolutely so, the second attack, however, when it does occur is invariably mild. In my own observation and enquiries, I have been unable to find evidence of any instance in which the same animal has suffered from two undoubted attacks of Texas Fever, neither can I find it in the literature at my command. The statement, however, is sometimes made that cattle from infected regions when shipped north and retained there during one winter, are, on their return South as liable to die as cattle which never have been on infected ground before. This hardly accords with our theory of protection conferred by a first attack, but like many other statements on this subject, it requires confirmation, and next summer the question will be tested by the return of some of the cattle shipped north this year.

Practical Questions Demanding Solution—The foregoing is not put forward as a critical review, but merely as a summary which can be readily understood by the non-scientific reader, of what we consider to be necessary for the correct understanding and appreciation of the experiments now engaged in. These have for their object the solution of the following questions, which as I take it, from a practical point of view, covers the whole field.

1st. The determination, as nearly as possible, of the extent of this State which is permanently infected.

2nd. The most practical and economical method of shipping Southern cattle without endangering the herds of the North.

3rd. Some means of diminishing the fatality to Northern cattle when shipped South.

The infected region in Arkansas—In the last annual report of this station, the course was given of the line bounding on the north the infected regions of this State, as established by the

Department of Agriculture. In a work of such magnitude as this, embracing the whole country from East to West, anything like accuracy could not be expected, and the boundary line was only advanced as approximately correct. The occurrence of outbreaks of Texas Fever among native cattle in parts of the State far south of this line, such as that which was observed at Newport, in Jackson County, during last summer, shows that any error of location was very much on the safe side.

As before said, regions as far South as Philips county were found to be free from infection. Unnecessary restrictions on the shipment of cattle may be, and are, the result of this inaccurate location, and this points to the necessity of further investigation with a view of discovering what parts of the State are infected, and what free from infection. This task, it is our intention to accomplish next season, and as much assistance in this may be derived from intelligent correspondence, it is hoped that those farmers, or live stock owners in the Northern and Central parts of the State who have any information bearing on the subject will communicate the same.

To enable those who are willing to assist in this undertaking to form an opinion as to whether their region is infected or not, the following general rules may be laid down as a guide.

A district is free from infection when cattle imported there from the Northern counties of this State, or from parts further North fail to contract Texas Fever during their first summer. Also when cattle imported from the Central parts of the State, and further South into this district infect the pastures and cause disease among the native cattle.

The opposite conditions indicate that such a district is infected.

Infection of pastures by stock cars—That stock cars containing Southern cattle may be the means of infecting pastures along the railroad tracks is now well known. Two outbreaks in Arkansas, during the present season, causing a total loss of something like seventy cattle have been personally investigated, and traced to their source.

Since the manure is the principal medium in which the

germs of Texas Fever are contained, and this is constantly dropping out beside the unfenced track, no other result could be expected, and until laws are enforced regulating the traffic in Southern cattle such outbreaks will continually occur. A certain amount of security might be obtained by requiring the cars to be closely boarded on the sides to the necessary height, watering and feeding cattle at certain places on the route in pens from which other cattle are excluded, and thorough cleaning and disinfection of the cars after unloading. These provisional measures have been recommended, and in part adopted in some of the Northern States as an alternative to total exclusion of Southern cattle.

Disinfection of the cattle themselves before shipment has also been proposed, and something was attempted in that direction in our experiments. From a scientific point of view such an experiment is not without value, but as a practical method, even if it were successful, my experience is not in its favor. To obtain complete destruction of the disease producing germs contained in the stomach and intestines requires the adminstration of large and repeated doses of disinfectants, which necessarily have to be forcibly administered, a task of too much magnitude when a large number of cattle are concerned to admit of the expectation that it would ever be faithfully executed.

Protection to Northern Cattle shipped South—In the last report in speaking of Texas Fever it was suggested that a means of protection to Northern cattle when shipped to infected regions in the South might be found in preventive inoculation, and this is the principal object for which we are now working. In the present incompleted state of our work it would be premature to say more than that the results so far obtained lead us to hope that this end will be obtained. The percentage of deaths among imported cattle in the Southern part of this State is somewhere over seventy per cent., and no means of protection at present in use seems to have much influence in diminishing it.

To this statement one exception must be made, which has already been mentioned, and that is that cattle shipped in, late in fall, or in early winter become to a certain extent acclimated

before summer, and thereby stand a better chance of surviving. Occasionally, however, as I am informed, they survive the first summer, and succumb during the second.

Calves imported while quite young also, as has been said, become gradually acclimated, and thus enabled to resist the infection. Another method by which the danger may be diminished, and which in the case of fine stock deserves to be well tested is, during the first summer to entirely exclude such stock from the pastures, and from yards to which native cattle have access, watering exclusively from wells. Late in the fall when the danger is much lessened they may be allowed on the pastures to become gradually habituated to the virus. The feed during summer would of course have to be hay and grain. In an experiment which will be detailed later, it will be seen that, however virulent the grass on a pasture may be, it entirely loses its virulence when dried, and may be fed with impunity to susceptible animals within at least two weeks from cutting. The regular administration of some germicide is also well worthy of trial; of these, sulphur is perhaps the most available as it can be given in large doses and is readily taken when mixed with the food.

I have usually recommended that it be given three or four times a week, mixed in feed in as large doses as the animal will take, intermitting its use when any sign of digestive disorders appear.

The faithful carrying out of these methods of protection is of course attended with some extra trouble and expense, which, however, may well be tolerated, when as is usually the case, the lives of high priced cattle are at stake.

Preventive Inoculation—The theory upon which inoculation as a preventive measure is based was suggested in the first part of this paper, namely, that a mild attack of the disease, naturally or artificially produced confers immunity from future attacks.

This method of combating the ravages of infectious diseases, although not quite a recent discovery, can hardly be said to have yet passed the embryo stage of its development. Among animal diseases its efficacy first demonstrated in Anthrax, by

Pasteur, has since been proved in "Black Leg," and notably by Salmon in Chicken Cholera. Inoculation against contagious pleuro-pneumonia of cattle has also been practiced for many years.

It would seem, from the peculiar conditions under which it occurs, that there is no infectious animal disease to which preventive inoculation, if successful, would be more applicable than to Texas Fever.

It would not require to be universal, but practiced only on cattle, mostly fine stock, which were intended to be shipped to Southern infected regions. Neither could it labor under the disadvantage (urged against its application to pleuro-pneumonia) of tending to perpetuate the disease and introduce it into new quarters. Such a method of protection would prove of incalculable benefit to the South by allowing the importation of the improved breeds of cattle so essential to the improvement of the native stock, without the risk with which such importation is now attended.

If, therefore, there is even a bare possibility of this end being attained, all efforts tending in this direction might well be encouraged and supported.

SHIPMENT OF CATTLE.

In accordance with an agreement entered into between this Station and that of Missouri for conjoined work, a number of cattle, twenty-six head in all, were shipped June 26th, from the neighborhood of Helena to Columbia, Mo., to afford material for work there. Phillips county was selected as a field for these experiments on account of conveniences in shipping, and because it was so far South in the State as to afford assurance that cattle shipped from it would prove a source of infection in the North, and this selection was justified by the results.

Of cattle shipped North to Columbia, Mo., we have at present, nothing further to say, except that a number of them will be returned to their original home next summer. The object of this has been already given. Besides this shipment of cattle, specimens of the organs, blood, etc., of healthy native

cattle slaughtered in Helena, for beef, were sent to the same place as well as specimens of the internal organs of Northern cattle which died from Texas fever.

July 9th, eight head of cattle arrived from Missouri and were placed at once on a pasture south of town, which was guaranteed to be fatal to northern stock, and the result proved that it was so.

The grasses of this field were Bermuda and Crab grass chiefly. It was an old pasture with a thick matted undergrowth of partly dead grass. The field was comparatively free from weeds and was well supplied with shade trees. Water was supplied by a small stream which flowed along one side of the field, and not more than half a mile from its source in the bluffs; this stream, before it entered the field was accessible to the native stock. Besides these from the north, the field contained a few natives.

The imported cattle were of common graded stock, evidently ranging from one to two years of age, and they were placed on this pasture in the expectation that at least some of them would die from Texas fever during the summer. As an evidence of the virulence of the poison on that field, it may be here said that seven of these, that is 87 per cent., died before the end of the month, or twenty-one days after their arrival. The first sign of sickness was observed on the 23d, exactly two weeks from the date on which they were placed on the pasture. Previous to this they all appeared to be in normal health. The sick animal, a heifer, about one year old, was standing apart from the others with head held low. On being approached, it suddenly raised the head with a startled and wild look, then started off on a run across the field. The next morning it was found lying in the shade, but started up on being approached, exhibiting the same symptoms as before, but in an increased degree. There was now also trembling and jerking of the muscles of the neck, with constant up and down motion of the head. There was also a disposition to rush at any intruder who approached too closely. As yet no difficulty in progression was observed. The symptoms were

readily recognized by men accustomed to dealing in cattle there, as the initiatory stage of one form of what they designate "Murrain." After a time, weakness in locomotion became manifest with staggering gait and spasmodic contraction of the muscles. On the 25th it was with difficulty made to rise, and when on its feet, the trembling and weakness of the limbs were so great that it soon sunk down again. There was no bloating. Breathing exceedingly rapid, 96 per minute, and a temperature, in mouth, of 105 deg. There was occasionally severe straining with passages of small quantity of faeces hardened and bloody. This case proved fatal in about forty-eight hours after the first sign of ill health.

The second case occurred three days later, exhibiting generally the same symptoms as the first, but the signs of nervous derangement were not so well marked, and in all subsequent cases, except one, these were almost entirely absent. The following table shows the number of days after arrival, on which the cattle of this shipment died:

1 died on the 25th, after arrival 16 days.
2 died on the 28th, after arrival 19 days.
1 died on the 29th, after arrival 20 days.
2 died on the 30th, after arrival 21 days.
1 died on the 31st, after arrival 22 days.

In none of these cases was sickness manifested more than three days before death.

The so-called "period of incubation" cannot, therefore, be more than two weeks, since the first evident sickness appeared just two weeks after first exposure. It may be less than two weeks, since we do not know that this animal became infected immediately after exposure. Fourteen days at least, evidently, must elapse after taking into the stomach and bowels the poison of Texas Fever before its effects become manifested. Whether or not this can be correctly called an incubatory period, there may be a difference of opinion. I have little doubt, but these cattle took into their stomachs the germs of disease almost with their first mouthful on their new pasture. The symptoms and after-death appearances, however, idicate that Texas fever is

not a local disease affecting only the digestive track, but one in which the poison become generalized, leading to alterations of the blood, and consequently interfering with all the vital functions. We may, therefore, regard the period of incubation as commencing only after the disease producing organisms have found their way from the digestive track into the blood, that is, have become generalized. Some subjects, evidently, are able to resist this invasion longer than others.

SYMPTOMS OF TEXAS FEVER.

The case described above shows some variations in symptoms from those which are usually seen in Texas fever. I will here give some of the most evident symptoms of a typical case, which can be readily recognized by even those not accustomed to exact observation. The sick animal stands apart from its fellows with head depressed. There is no desire for food and rumination is suspended. A wild and staring look of the eyes is often seen at first, but this is not a constant symptom nor peculiar to the disease. In most cases, about 80 per cent of those I have seen, the urine at this stage is deepened in color, generally a light brown. Later it becomes a dark red. There is more or less constipation; this symptom being most marked in those which survive longest. In some which died from a very acute attack, there was no constipation. The muzzle became dry and the ears hot; the temperature taken by thermometer in the mouth or rectum at this stage may range from 103 to 106. Breathing is rapid, but there is little or no cough. Generally the sick animals seek the shade and lies down most of the time. One symptom frequently observed is licking up and chewing dirt from the ground.

Then comes muscular weakness and trembling of limbs when forced to a standing posture. There is often straining and symptoms of abdominal pain towards the last. The conjuctiva is usually pale, whilst the membrane lining of the nostrils is streaked with red. In last stages the head is held extended with the nose on the ground, and death comes on usually with little struggling.

POST-MORTEM APPEARANCE.

Only the most evident changes will be here noted. Under the skin, the fatty tissue is often yellower than natural, and streaked with red, but this is sometimes not noticeable. The blood flows readily from the larger cut vessels, and generally does not clot as readily as usual, but I have never seen it quite uncoagulable. A well marked and almost constant symptom is seen on removing the skin from over the ribs. This is the presence of small lymph glands which are quite black in color and swollen with blood. The larger lymph glands found beside the large vessels inside the arm and in the groin are also darkened, but not to the same extent. The lungs are always spotted dark in places, but never solidified. When cut they show their natural, spongy character, and exude a dark yellow, frothy fluid on the cut surface. There is no effusion of fluid into the cavity surrounding them. There is nearly always an effusion of fluid, of a dark or light red color into the heart sack, and in all the cases yet examined, the heart itself was much reddened, often a dark red. Lining of the heart cavities also stained often with dark spots and streaks. This abnormal condition of the heart was one of the most noticeable after death appearances among the catttle which died on the infected pasture at Helena. The cavities of the heart rarely contain clots of blood. The liver is enlarged, sometimes very much so, but its condition otherwise is not constant; in some cases being yellow in color and evidently surcharged with bile, which flows freely from it when cut, whilst in other cases, and these are the most common, it is deeply congested full of blood, and of a dark color on the surface. Bile in gall bladder usually dark and abundant. Spleen almost invariably swollen, but to a very variable degree. The surface is spotted and streaked a bluish purple, and in consistence the whole organ is plainly softened. It is distended with blood, but the contents not fluid, nor in our experience do they gravitate to the lower end when the spleen is held up, as has so frequently been stated. When cut, the surface bulges out and appears soft and almost black.

Manyfolds may be packed full or only moderately filled. The contents are rarely hard and dried, except when the course of the disease has been slow. I think that the appearance of the manyfolds after death often gives rise to misleading ideas of the cause of death. In cattle that are slaughtered in perfect health, this division of the stomach is nearly always full and the contents moderately hard, and when an animal suffers for some days before death from a febrile disease, these contents are always found hard and apparently impacted. The other divisions of the stomach, except the fourth, are normal in appearance, but the fourth division has its membranous folds congested, and of a dark purple color. This post-mortem appearance has not been missed in any cases yet examined, and it is one of the most characteristic in Texas fever. The great bulk of the intestines when opened, often show no important changes, although sometimes, evidently congested, but the rectum or posterior bowel is very often much congested and sometimes contains blood clots mixed with hardened pellets of faeces. The kidneys also vary somewhat in appearance in different cases, sometimes appearing almost normal. In general, however, they are swollen and darkened, occasionally streaked red on the surface.

In one case (a fatal result of inoculation) they were found to be of a pale color and diminished in size, with, as seen under the microscope, their secreting structure almost completely destroyed.

The appearance of the bladder and urine is, perhaps, the most characteristic of all, and as a simple diagnostic sign, the most important. It is full, but not often inordinately distended, and the urine has the deep tinge before mentioned. The color varies from a light red to a purple or almost black, and it shows through the walls of the bladder as a deep green. In a few cases, it is of an amber color, and apparently little altered. I have been unable to trace any relation between the degree of morbid change in the kidneys and the amount of discoloration in the urine, nor do I think there is any. The color of the urine indicates disorganization of the blood rather than

of the kidney. Strictly speaking, the urine is not bloody; the most careful microscopic examination, except in rare cases, fails to reveal the presence of blood corpuscles; neither in any specimens that I have tested, has it been markedly albuminous. The abnormal color is doubtless derived from the breaking up of the red blood cells, setting free their coloring matter which is excreted by the kidneys. If asked what were the after-death appearances by which the cause of death could be most easily recognized, I should say that they were to be found in the blood, liver, spleen and fourth division of the stomach, and in the bladder and lymphatic glands, as above described. The result of the first shipment of cattle seemed to justify the Missouri Station in making a second, and, accordingly, at mutual expense with this station, a second lot of eleven head arrived from Columbia, Mo., August 13, one being dead on arrival. Post-mortem examination of this case revealed the following changes which, as the cause of death might possibly be disputed, we will consider it desirable to make a record of.

The animal died on the night of the 12th, having showed signs of sickness twenty-four hours before death, with (according to the statement of the attendant) swaying from side to side. It was opened, perhaps, twelve hours after death. There was no rigidity of muscles. These on being cut, were pale in color, and there was no flow of blood on cutting the femoral vessels. There was a slight odor of decomposition. Inguinal glands not markedly swollen or discolored. Lungs spotted dark in places; no consolidation. Heart substance pale and soft; endocardium not discolored. Ventricles almost empty. One contained a small, dark, soft clot. Slight red pericardial effusion. Mucous membrane of fourth division of stomach but slightly discolored. Liver large and stained yellow. Gall bladder full of thick, yellow bile. Spleen enlarged, dark and quite soft, appearing almost black on section. Kidneys much altered, either by disease or decomposition, the surface and cortex being soft and dirty gray in color; urine dark red and fæces in rectum soft.

The following table shows the number of days after arrival on which the second lot died or became sick.

1 dead on August 13th, on arrival.
1 died " " 30th, after arrival, 17 days.
2 " " " 31st, " " 18 days.
1 " " " 27th, " " 14 days.
1 " " Sept. 1st, " " 19 days.
2 became sick August 28th, after arrival, 15 days.

In those which died, the duration of evident sickness was the same as in the first lot, namely, from two to three days. The post-mortem appearances also were similar.

Two, as will be seen, became sick and subsequently recovered. They were sick about two weeks, showing the same symptoms as in fatal cases, but less aggravated. Muscular weakness and trembling was not noticed in these and in one of them the urine did not become altered from the normal. In the way of treatment, something was attempted in the second lot. In the first one, the object being to obtain specimens and observe the course of the disease, no treatment was attempted. Of the latter shipment the effect of drugs was tried upon four, but little success was obtained. As soon as observed to be sick a large dose of purgative medicine was given, and this followed in two cases by quinine in large doses and in two others by carbolic acid given in sufficient quantity of water. The carbolic acid treatment was tried on the two which recovered, but we are not prepared to say that this treatment was the cause of recovery, although it may have contributed to that result. I think it is doubtful if any treatment would be successful in a very severe attack.

Of the last shipment, six died out of eleven; two became sick and recovered, whilst three never showed any signs of sickness. These cattle will be retained there during next summer to note if any further deaths or sickness should occur.

Nothing has been said of the preventive inoculation and its effects on these cattle, nor can any report on that subject be made until the reports from the other stations concerned are published. This according to an understood agreement.

Feeding Hay from Infected Ground.—To test the effect of drying and curing of grass from infected pastures, on the virulence of the Texas Fever germ, about eight bales of grass from the pasture where our cattle were kept, was cut Oct. 1st to 3d, close to the ground, so as to include much of the dried and dead grass below. It was obtained from several parts of the infected field and allowed to cure in the usual way in small bunches. After being baled, (through the kindness of Mr. Clopton) and completely closed in by packing, it was shipped to Fayetteville. On an unoccupied farm several miles from town, a close fence was built and two cattle obtained in the neighborhood were subjected to this feeding experiment. These cattle were raised in a neighborhood which has never been infected and consequently were susceptible to the pathogenic action of the Texas Fever germ if it retained its virulence.

Besides the hay, which they readily ate, a little corn meal was allowed. The feeding lasted one month, and the effect was entirely negative. The cattle remained healthy and improved in condition. The weather during the whole time, from cutting of the grass to the close of the experiment, was warm and without night frosts. The result of this experiment was different from what was expected. The virulence of Texas Fever must reside either in the pasture or in the drinking water, or in both. From the manner in which northern pastures and the neighborhood of railroads become polluted, there is little doubt that the grass and soil in most cases, are the source of infection, and not the water, and consequently, we might expect that grass cut as this was from a pasture extremely deadly to susceptible animals, would itself contain the virulence.

The most probable explanation is that which has been mentioned, namely, that drying has the effect of destroying either the life, or at least the virulence of the Texas fever germs.

We refrain, in this paper, from any reference to the disease from a bacteriological point of view. Not having on hand the necessary apparatus for bacteriological study, nor sufficient time to engage in it, but little was attempted in this line. Specimens, however, were obtained for future examination,

both from diseased animals and from healthy natives, and these will be subsequently reported on.

From certain preliminary examinations, however, I judge that the discovery and demonstration of the causative agent in this disease will be attended with as much difficulty as in any other which has yet been successfully investigated.

SPAYING OF CATTLE.

This has been made the subject of some experiments and investigation lately, and as it is a question of much importance and wide divergence of opinion, and one which is likely still further to engage the attention of the Western cattle owner in the future, we consider it desirable to draw the attention of the farmers to it now, although our experiments in this line are intended to be continued as opportunity occurs. Conclusions on a question of this kind ought to be drawn from and based upon extensive observation and experience, and it is hoped that this may be the means of inducing others to experiment in the same line, and thus supplement our own work.

Spaying of cattle is an old operation and one which has generally been discouraged in veterinary works, as operations of convenience rather than necessity usually are; but under certain conditions it would seem that the operation may be justified by the advantages gained in the economic raising of cattle. It has been performed extensively in European countries with reported good results, and within the last few years has been introduced among the cattle of the West, and it would seem that the conditions which render spaying profitable as an economic factor in beef production exist to their full extent on our ranges of the West and Southwest. In the spaying of dairy cows the object aimed at is the production of milk rather than of fat. Cows that are spayed at the age in which they give the largest yield of milk—after third calf—provided they are fed and tended properly, continue to milk in almost undiminished quantity, ex-

cept as influenced by the food, for a very considerable period after being thus operated upon. The length of time is somewhat uncertain, but is usually stated to be two or three years, and as a rule the diminution in the flow of milk is accompanied by a gradually progressive accumulation of fat. Spaying for this purpose has been practiced, although only to a limited extent, in many of the dairy farms of the East, and when performed on such cows as are from any cause undesirable to breed from, there seems to be no question of its utility. Spaying also has long been recognized as having a beneficial effect on the quality of the milk, increasing its fatty and nutritive properties, although I am not aware that this has been experimentally tested. We hope in the course of these experiments to determine this point by chemical analysis of the milk of the same cow before and after spaying, as well as by the practical test furnished by butter production in the dairy. The quantity and quality of the milk secreted, depending as it very largely does upon the maintenance of a quiet and equable temperament in the cow, we should, *a priori*, judge that the removal of the ovaries, by preventing the periodic recurrence of sexual excitement, would tend to have a favorable effect upon the lacteal secretion. However this may be, there is little doubt of its utility when applied for the purposes which we here principally advocate; that is, the conversion of hundreds of native cows and heifers found on the ranges of this State, which are at present undesirable as breeding animals, into stock which can be profitably fed for beef. The experience we have had so far lead us to believe that this can be done, and the experiments conducted on a more extensive scale by the Missouri Station, are also favorable to the operation. The description previously given of this very simple operation ought to be sufficient to enable any one possessed of ordinary manual skill to perform it with safety and success, and although there are many stockmen who would be averse to operating themselves, there are doubtless in every neighborhood some who would be willing and competent to undertake it.

The classes of animals which should be selected have already been partly indicated, and include: First, and chiefly,

heifers under one year old, which are not intended for milk cows, and which are not wanted for breeding purposes. Second, older cattle, either heifers, or cows that have had one or more calves, and which it is desired to fatten for beef; and, finally, cows in any dairy in full flow of milk, and whose calves it is not profitable to raise, may be included as suitable for testing the effect on the milk production.

It is among the first two classes of animals that we consider the operation would be found most profitable in the West, not only from the immediate profit to the owner, but also from its tendency to diminish the number of scrub animals and favor the introduction of a better class of cattle.

To successfully operate, it is desirable to obtain some idea of the anatomy of the parts and thus know the dangers to be avoided.

The descriptive anatomy of these parts and manner of operating which has been found the simplest and most successful are given in Bulletin No. 8, recently issued by this Station, a copy of which may be obtained on application by those interested in the matter who do not already possess it. Further experience since the issue of that bulletin has shown that the chief obstacle to the introduction, and more general practice of spaying beef cattle on the ranges, is due to an exaggerated idea of the danger and difficulty of the operation. By carefully reading and following the directions given in the Bulletin referred to, no one of ordinary dexterity need fail to acquire the requisite skill.

The experiments in spaying and feeding which have been carried on at this station demonstate the advantages to be derived from this operation.

A number of cattle of ages varying from six months to eight or ten years were made the subject of experiment. Of these the best results were obtained in those under one year. The animals experimented on were of the common stock, badly formed and evidently poorly adapted for laying on of fat. They were bought in the early winter and it was designed to fatten them for sale in spring. One was a calf of six months, one a heifer of about eighteen months; the others were two, three

and nine years old. The calf showed no fever nor impairment of appetite as the result, and the healing of the external wound took place earlier than in the others. She now looks in much better condition than the ordinary stock of her age.

A heifer of about eighteen months spayed in the flank, December 6th, and fed like the others twice daily on crushed oats and bran with hay, showed an average gain of 2.8 lbs. *per diem* till date of sale, March 8th; weight then 742 lbs.

Another cow, after losing twenty pounds during the first two weeks, made a steady gain afterwards of about twelve pounds per week. Two others proved in calf at the time of operating and both aborted on the third and fourth day following. They exhibited more constitutional disturbance, with some loss of appetite and fever, and a loss in weight of about fifty pounds in the first week, largely accounted for by the weight of the fœtus and envelopes. Afterwards they improved and continued to increase in weight like the others.

In other parts of the State where spaying has been introduced, the results have been reported satisfactory.

From observations on our own and other animals, we conclude that spaying should not be undertaken on cows that are at the time pregnant, nor is it likely to be of much benefit on very old animals, or such as from their general appearance are evidently bad thrivers with weak powers of digestion. Spaying will not convert a poor milker into a good milker, nor will it do away with the inherent bad points which characterize the lank and unthrifty animal; but performed upon ordinary stock, selected according to the indications previously given, it will be found profitable both by hastening maturity and by enhancing the marketable value of the flesh.

Experiments are at present under way to test by analysis the difference, if any, in the percentage of total solids and fat in the milk of the same cows before and after spaying, and the results will be published in a future bulletin.

REPORT OF THE ENTOMOLOGIST.

LETTER OF SUBMITTAL.

SIR: I have the honor to present herewith my second annual report. The report naturally does not represent more than a small fraction of the work of the department, as it is the plan not to discuss all the large number of insects that come to my attention by their effects upon cultivated crops, but to give in a brief form the methods of defence against those insects which have come into prominence on account of the amount of their damages, and to treat fully a few of these.

The correspondence of this department has increased during the year in a very satisfactory manner showing an awakened and increasing interest in the matter of economic entomology. I would urge farmers more generally to take advantage of this opportunity and write whenever they are troubled with destructive insects. Specimens of the insects or their work should be sent whenever possible. They go by mail at the rate of one cent per ounce. Put them in a small wooden or tin box and never in a pasteboard box, or in the letter, as they are almost sure to be crushed and rendered unrecognizable. No air holes need be made as they go better in a tight box.

To make this phase of my work of more general value it is proposed to make free use of the press the coming season, publishing such parts of the correspondence as is of general interest. This will enable me to reach the people oftener than is possible through the regular publications of the station and to place on record in an accessible place the condition of the cotton worm from time to time, its progress towards and in our State, thus serving as a system of warnings for the benefit of farmers in threatened localities. These newspaper bulletins will be compiled at the end

of the season and presented in the regular station publications

Appended to this report will be found an article upon botanical subjects.

Respectfully,
C. W. WOODWORTH,
Entomologist.

To PROF. A. E. MENKE,
Director of the Ark. Agr. Exp. Station.

ARTICLE I.—NOTES OF THE SEASON.

It is intended under this head to present each year an account of the destruction caused by the worst of our insect foes, and to present methods of fighting them. The loss caused by insects has been quite large the past season.

Cutworms:—These insects are well known to all tillers of the soil. The moths that produce them are about the size of the cotton worm moths and are often mistaken for them. The eggs laid in the fall soon hatch into small larvæ of dingy colors. These feed upon grass or almost any sort of plant and attain to perhaps half the size of the mature larvæ when they are overtaken by winter. Under stones or in the ground they find convenient hiding places where they remain till spring. They then feed voraciously on almost anything green that they can find, and at this time do their greatest damage by eating through the stems of young plants near the surface of the ground. When they have satisfied their hunger and become full grown they proceed to bury themselves in the ground for their final transformation to the moth form. These moths lay eggs which produce generally at least a mid-summer brood and then this cycle of yearly development is repeated. The mid-summer brood of worms generally do but little injury and only in the spring do the damages of the winter brood amount to anything. The best remedy is the poisoned bait which consists of bunches of grass or clover which have been dipped in a solution of poison (London purple or Paris green) or thoroughly dusted with the

same. These baits are laid on the ground after it has been plowed. They will attract and kill the hungry worms. If a board is laid over the bait it will keep green longer.

The Tarnished Plant Bug :—Considerable injury was done this year near Fayetteville, but I have no means of knowing how much injury was done in other parts of the State. There is no doubt but that it was one of the chief agencies in the blasting of the blossom buds this spring on the apple and pear trees. Article two of this report is mainly a reprint of Bulletin 10 of this station where the insect was quite fully treated.

The Chinch Bug:—The chinch bug did a large amount of damage in the northern part of the State this year and produced quite a scare, but the heavy rains just after harvest and the condition of the atmosphere favored the development of diseases which so completely destroyed them, that in many places where they were swarming before, it was with difficulty that one could find a single specimen. Everywhere the destruction of the bugs was complete enough to prevent any further injury to corn. Reports which were received from nearly all parts of the infested region indicate that no fear need be entertained of their doing any injury next season. In response to requests for information, I present in Article three of this report a resume of what is known of the life history of this insect and the remedial measures.

The Hessian Fly:—Some complaint has reached me regarding injuries to wheat by this well known pest. It might be worth while to indicate what seems now the best method of prevention. The Hessian fly is three or four brooded. I have not been able to work out the life history in this State so as to be able to give exact dates, but it is substantially as follows: The insect passes the winter as larvæ or pupæ, which are popularly known as the maggot and flax-seed stages. It is only in these two stages that the insect seems to be able to pass the winter successfully. In the spring flies are produced which lay the eggs that soon develop into the first or spring brood of maggots which do the most injury, though a second or summer brood may be developed before harvest and also be injurious.

After harvest, if this summer brood has not come in time to attack the large wheat, it must live on volunteer wheat, and at any rate there is a fall brood developed which is forced to this necessity. The fall sown wheat becomes the victim of the winter brood and thus the cycle is complete. It is the time while the insect is living on volunteer wheat that we have the best chance to destroy them. This is the treatment suggested: Plow your wheat fields not long after harvest and allow the volunteer wheat to come up, thus giving the fly a convenient place to lay their eggs. Now in about a month turn this wheat under and you will have trapped and destroyed the insects. This method is most effectual if all the farmers in a whole neighborhood unite in giving the fly the same treatment.

The Striped Cucumber Beetle (Diabrotica vittata Fabr):— One of the commonest of our garden pests is our striped cucumber beetle. This insect appeared in some places quite destructive to cucumbers, squashes, etc. They are easily destroyed by the application of kerosene powder made by mixing five to eight parts of kerosene to a hundred of any convenient powder, as road-dust, flour, ashes, etc.

The Grape Leaf Folder.—Though quite abundant this year in this locality, the grape leaf folder was not as destructive as last year. A large per centage of paracitism occurred, and therefore, even smaller numbers are to be expected the coming season, notwithstanding the fact that hardly anything was done to destroy them this year. I can but repeat the suggestions of remedies proposed in the first report and would emphasize the necessity of removing the infested leaves, for otherwise they are but invitations to the insect to deposit its eggs there. If this is done often enough we will not at the same time destroy our insect friends.

The Grape Leaf-Hopper.—Most grape insects were not bad this year, but the grape leaf-hopper seems to have been more than usually numerous. All grape growers know this insect under the name thrips. There may be several species, but they all belong to the genus *Typhlocyba*. The name leaf-hopper,

is the proper one, as the thrips is really a very different kind of insect. As for remedies, none really satisfactory for use in the ordinary vineyard have been used except the torch traps, such as used by the cotton planters in parts of this State the past season. A full account of how to make them will be found in the appendix, of article 4. A few of these lit each night in the vineyard will very soon perceptably diminish their numbers.

The Grain Plant Louse.—Much complaint has reached this office about the work of the grain plant louse (*Siphonophora avenæ*), in oats and wheat especially, in the northern part of the State. This insect, like the chinch bug, does best in rather dry weather, and in such years is to be looked out for. It is a very difficult insect to contend with, not that it is hard to kill, but on account of its enormous powers of increase, and the expense of applying insecticides to large fields. Kerosene emulsion is sure death to the insect, but quite expensive. There may be times when it would pay, but oftener its costs will be too near the amount saved by it to warrant its use. London purple will probably be the most available remedy. The poison has considerable corrosive power, as is well shown by its scorching effect on the leaves of plants when too heavily applied. The grain plant louse has a very tender skin, and is readily killed by the application of this poison. The most convenient means of applying it is probably the dusting plan used for cotton. The apparatus is described in the appendix to Article 4. For use in the wheat or oat fields on accout of the danger of breaking down the grain, if a mule is used, the duster should be adapted to a man's shoulders, by an arrangement like the yoke used for carrying water. A man alone can cover about as much ground in a day as a man and a mule together.

The Peach Tree Borer. (*Ægeria exitiosa*)—This well known insect is one of the worst enemies to the peach tree in this State. Two classes of remedies are used against the borer, one having its object, the destruction of the insect after attacking the tree, and the other of preventing the attack. Of the first class, cutting out the larvæ, or using hot water are the most practiced. Recently I have been experimenting with kerosene

oil for that purpose with very excellent results. My plan is to scrape the dust away from the collar of the tree so as to expose all attacked parts, and apply the kerosene direct and freely with a brush. The earth must then be thrown up to the tree so as to cover all the parts wetted with the kerosene, and it will absorb the excess of the oil and prevent all injury to the tree. This remedy is not expensive, and is much more certain in its action than hot water.

Of the second class of remedies, the plan in successful operation in Florida seems to be the best yet recommended. It consists in coating the parts liable to be affected with a highly poisonous paint. The following is a good formula: Soak one pound of common glue over night in cold water, then dissolve in one-half gallon of hot water. Add an ounce of London Purple, stirring well, and then add enough hot water to make two gallons. The dirt should be removed and the mixture applied while warm. If these remedies are used thoroughly, there need be no further trouble from this dreaded pest.

The Bag Worm. (*Thyreodopteryx ephemæriformis*).—Every one is acquainted with this insect, or rather with its house, which it carries around on its back like the snail does. It feeds on a large number of trees, and has been, the past season, quite destructive to both orchard and shade trees. Spraying with London Purple, as done for the coddling moth, 1 lb. London Purple to 100 gallons of water, will entirely clean a tree of this insect, and when the trees in the orchard are properly sprayed for that insect they will not be troubled by this.

The Cotton Worm.—The cotton worm appeared quite early last spring and did considerable damage. The damage would have been much more had not the poisons been used quite freely. A full account of this insect will be found in Article 4.

The Boll Worm.—In the northern part of the cotton region the boll worm is nearly or quite as bad as the cotton worm. It did considerable damage this year, but hardly as much, according to the reports received, as did the cotton

worm. The habit it has of burrowing into the boll puts its out of reach of poisons as ordinarily applied, and is, therefore, a very difficult insect to combat. There is one peculiarity of this insect, however, which may give us a ready means of successfully defending ourselves. It has been my experience, and that of quite a number of planters with whom I have conversed, that the insect prefers corn, when in the right condition, to cotton, especially sweet corn. Now, why cannot sweet corn be planted so as to have some coming on all through the year, and cut for fodder before the worm is fully developed, and in this way trap and destry the worm. If this means is successful, the cotton may be protected at little or no cost. In using this remedy, especial care should be taken not to allow any of the worms on the corn to come to maturity, or the result may be worse than if you had not planted the corn at all.

The Codling Moth.—The amount of sound apples that can be obtained in the market in Arkansas is remarkably small. The greatest hindrance to successful apple culture in this State, is the codling moth. Arkansas can raise some of the best fruit in the world, but the demand for our apples is not great, and one of the chief reasons is that they are so wormy. When the fruit growers in Arkansas learn to use the methods of spraying that gave the Michigan apples such fame, they can expect a ready market at a good price. Then to mark a barrel "Arkansas apples," will be its best advertisement. The cost of spraying is not heavy, the method simple and the net returns of good, sound fruit very satisfactory. All that is needed is a force pump, a spray nozzle and enough hose to allow you to easily spray all parts of the tree. Mix a pound of London Purple or Paris Green in a hundred gallons of water and spray the trees thoroughly when the apples are about the size of peas, and repeat two or three times during the season. The poison in quantity should not cost more than 15 cents a pound.

ARTICLE II.

THE TARNISHED PLANT BUG. *(Lygus lineolaris, Beauv.)* The insect bearing the above name is one remarkable in its uni-

form presence every year and at all times of the year. It is found in almost if not quite all parts of the United States and extends far up into the British possessions north of us. It is also a most general feeder, loving anything that is tender and succulent, living in the spring on the opening buds, and later on the new shoots, the flowers, and the fruit, and doing an amount of injury, which on account of its being done every year is quite apt to be overlooked. Although it has been known ever since the days of Harris to be injurious, and at times has been so destructive as to rival even the first-class insect pests, it has never received an exhaustive treatmeut at the hands of Entomologists till about six years ago, when Prof. Forbes, of Illinois, took it up. Its destructiveness to orchards, this spring, makes it desirable that information concerning it be given to the fruit-grower, and to others who may be troubled by its depredations. Like all the order to which it belongs—the true bug—it is destitute of jaws, but derives all its food by puncturing the plant and sucking up its juices. The following statements of the injury caused by this insect will give some idea of the effectiveness of this method of attacking vegetation.

IN THE FLOWER GARDEN.

Mr. Harris states that in 1838, when this insect was very abundant and destructive in Massachusetts, the flower-gardens suffered considerably, and mentions dahlias, marrigolds, asters and balsams. I have never seen further record of flowers being injured by this insect; but this is not surprising, since so little is written about insects injurious to flowers.

IN THE VEGETABLE GARDEN.

This insect is reported as being at times very injurious to cabbages, turnips, and especially to late cucumbers, but it is on account of its attacks to the potato that the greatest amount of complaint is heard. It is very injurious to this plant, as the following extracts will show. The first account of its attacking the potato is given by Harris in these words: "On visiting my potato-patch shortly afterwards, I found the insect there also, in great numbers, on the vines; and, from information worthy

of credit, am inclined to believe that these insects contributed quite as much as the dry weather of that season to diminish the produce of the potato fields in this vicinity. They principally attacked the buds, terminal shoots, and most succulent growing parts of these and other herbaceous plants, puncturing them with their beaks, drawing off the sap, and, from the effects subsequently visible, apparently poisoning the parts attacked. These afterward withered, turned black, and in a few days dried up, or curled, and remained permanently stunted in their growth." In commenting on the work of this insect on the potato, in Missouri, Prof. Riley remarks: "I have passed through potato fields along the Iron Mountain Railroad, in May, and found almost every stalk blighted and black from the thrusts of its poisonous beak, and it is not at all surprising that this bug was, some years ago, actually accused of being the cause of the dreaded potato rot."

IN THE FIELD.

It is very numerous at times on wheat, oats and corn, and especially so on meadows of red clover and alfalfa. Mr. F. M. Webster writes about it as follows: "I have here to add another to the long list of depredations of which this insect has been accused. Late in June and early in July I observed both pupæ and adults puncturing the kernels of wheat and extracting the milk, thus causing them to shrivel and dry up, or to become mouldy and discolored."

IN THE NURSERY.

At times this insect has proven itself terribly destructive to nursery stock. Mr. D. B. Wier, of Lacon, Ill., an extensive nurseryman, has given a very graphic account of his experience with it, in the *Prairie Farmer* for 1872. He says: "What the chinch-bug is to the spring wheat-grower, this bug is to the nurseryman and fruit-grower, in regions adapted to its multiplication, and, like the chinch-bug, there seems to be no means of combating it, with much chance of success. I have lost, within the last three years, by its ravages in our nursery and orchard, enough to pay the salary of our State Entomologist. I

have closely studied it during that time, and to-day I feel that I shall stand, next spring, utterly impotent to combat it successfully, and see it blast my winter's work of grafting, in a great measure, and destroy every germ of plum and pear on my grounds, making my rows of young pear and plum trees look as if they had been singed with fire during four long weeks.

"As soon, in the spring, as the first buds on our pear, mountain ash and quince begin to burst, and the days are bright and warm, these bugs eommence to feed on them, and every bud that they pierce with their poisonous beaks is utterly destroyed. As the terminal bud is first to push, it goes first, and then each successive bud down the branch; so, if the tree is small, and there are bugs enough, every free bud on the tree is killed, and it has to push its dormant buds. These are destroyed in the same way, and the tree stands for a long time after this rough treatment, apparently considering whether life is worth the immense effort of arranging cells for new points of growth, to be destroyed in their incipiency. It goes to work, and doubtingly, timidly, and weakly, sends out its best, though spindling, effort. If the Capsus captures this last effort, and the tree is weak in its store of food, it throws up the sponge; if not, it makes a weak, unsightly growth, for the reason that the new shoots do not start from proper axes.

"The buds of root grafts cannot stand many stoppings; so, where these bugs are plenty, the rows show this, indeed. After feeding and destroying in this way for about a month, the female lays her eggs and dies."

IN THE ORCHARD.

The tarnished plant bug attacks the trees in the orchard in the same manner as in the nursery, but owing to the greater amount of reserve force that a tree has after it has attained some size, it is by no means so deadly in its work. The insect has another means of doing injury in the orchard. It is by puncturing and blasting the blossom buds. Pears seem to suffer most, though apples are nearly as bad. Some trees in the Station orchard, on account of the work of this pest, have ab-

solutely no fruit on them, although they were as full of buds as usual. Generally, the punctured bud would turn black and drop without opening, but sometimes it would bloom, but seldom or never set any fruit, as far as my observation goes. I have marked a large number of stems which had one or more bugs on, and with every bud showing that it had been punctured; though some of them bloomed, none of them set any fruit. Undoubtedly one of the most important factors which go to keep the trees from setting much fruit is this little insect. Besides the pear and apple, this insect is quite bad on the cherry, plum and quince.

ON SMALL FRUITS.

Sometimes, when this insect is very abundant, it does considerable injury to raspberries and blackberries, by puncturing the nearly ripe fruit and so shriveling it. The crop generally comes to maturity at such a time that there is plenty of other food for the bugs, so they are rarely very destructive. Strawberries are often affected by what is know as "buttoning," entailing, often, thousands of dollars of damage. It consists of a sort of shrinking and drying up of a part or the whole of the berry. It is present at almost all times, in more or less abundance, and probably due to a large number of causes. It is mainly due to this insect, as has been pointed out by Prof. Forbes, of Illinois. In 1883 it was quite bad in Southern Illinois, destroying, it is estimated, from five to ten thousand dollars' worth of fruit on the fields of a single grower, Messrs. Earl and Son, of Cobden.

DESCRIPTION.

The egg.—Like other insects, the tarnished plant bug passes through an egg stage. Very little is known of the place or method of egg-laying in this insect. The egg was not known at all till 1884, when Prof. Forbes, after a protracted search, succeeded in finding among the hairs of the petiole of a dead strawberry leaf a single specimen, which he identified by comparison with some obtained from the female, by dissection. Since that time, as far as I am aware, it has never again been observed. We have spent considerable time in fruitless search

this spring. We have repeatedly dissected them from the adult insect, and represent one so obtained in figure 1. It is smooth and shining, of a pale yellow color. It is about a hundredth of an inch in diameter at its widest part, and four times as long. In shape it is a flattened cylinder. The lower end is evenly rounded, the upper, after a slight contraction, expands again into a thick oval plate of darker color. The reason this stage should be such a mystery is explained, I think, by a fact that has been generally overlooked. This insect is provided with an ovipositor, developed into a beautiful saw-like instrument, and therefore, should not be expected, like most bugs whose life histories are known, to deposit their eggs free on the food plant. With this new clue we are attempting to complete the life history at this point, but the extreme difficulty of keeping the insect alive, in confinement, makes it no easy task.

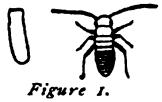


Figure 1.

1st Larval Stage.—The insect, on emerging from the egg, is called a larva. During this period of an insect's life it usually changes its skin a number of times. The tarnished plant bug does this three times before it changes into the adult condition. The larval stages are the periods of growth of the insect. The insect continues to feed in the latter stages, but the main part of the growth takes place while it is a larva. Upon hatching, this insect is of a very pale green or sulphur yellow color but in a short time, after feeding some, it takes a more decided tint. The shape and general appearance is well shown in figure 1.

2d. Larval Stage.—Upon entering upon this stage the insect is almost twice as long as at the beginning of the first stage. It has the same green color and often is as entirely without markings as the first stage, but sometimes the five spots described as appearing in the next stage are present. It has the same long legs and antennae or feelers, but the shape of the body has altered some, becoming more bug-like. Figure 2 shows the appearance at this stage.

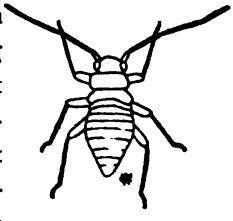


Figure 2.

3d. Larval Stage.—The insect in this stage is always marked by five dark spots. A pair on the first segment of the thorax—that is, the first joint back from the head. Another pair on the segment just behind that, and the fifth on about the middle of the abdomen or more exactly on the line separating the third and fourth abdominal segments. There is often besides this a mottling of the whole back and now and then various markings of crimson. The second and third thoracic segments extend backward at their outer angles and cover one or two abdominal segments in part. These extensions are the rudiments of the wings to develop later. This stage is represented in figure 3

The pupa.—The stage just before the adult form is called the pupa. A majority of insects are quiescent in this stage, but such insects as bugs and grasshoppers are active and feed during this stage just as in the larval stages. The five dark spots described above are still present; besides them there is always a large number of indefinite dark markings very variable in both number and position.

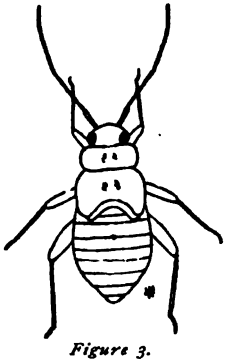


Figure 3.

Figure 4 represents a very common style of marking, but one of the least marked. The legs at this stage have begun to possess annular markings near the tip of the femur or thigh.

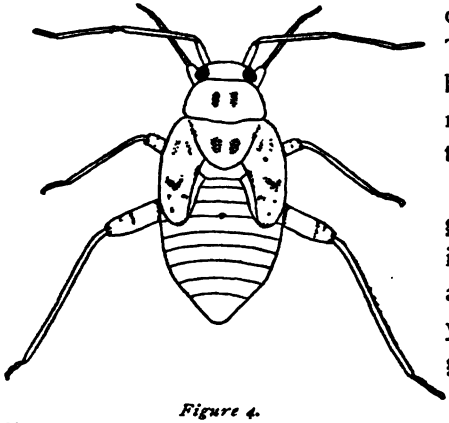


Figure 4.

The adult.—The full grown tarnished plant bug is oval, about one-fifth of an inch in length. When young is yellowish or greenish, spotted with numerous brown markings. When older it becomes much darker, or almost black.

The head, when seen from the front, is triangular, with two rows of punctures down the face. Seen from above it is oval, with large, conspicuous rounded eyes, generally of a black color, but sometimes reddish. The head is often uniform in color, but generally there are a number of obsolete dark markings. The most constant of these is a dark, median stripe.

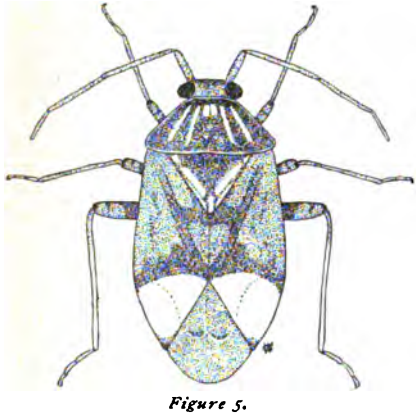


Figure 5.

The prothorax is, in shape, as shown in figure 5. In color it is of the various shades of green or brown, corresponding to the general color of the insect. It is darkest in front, and margined all around with a narrow, white line. There are also generally four white lines radiating backward, and four spots within, indicating the place of two more lines. These are often very obscure.

The scutellum is triangular transversely roughened, brown, with white markings varying in shape between a Y and a V. This mark is a very characteristic one in this species, and one that remains distinct after all the others are obscure.

The elytra or anterior wings present three well marked regions, a darker basal one, with longitudinal brown markings, a light colored nearly creamy white triangular portion, which has a single brown patch at its tip, and a membraneous terminal portion, in which the veins show quite distinctly. This terminal portion of the two elytra overlaps when at rest. The wings beneath the elytra are very delicate and translucent.

The femora or thighs are annulate with brown, as shown in the cut. Beneath, the body is much lighter than above, marked with brown and red in as variable a manner as it is above.

LIFE HISTORY.

This insect passes the winter generally in the adult con-

dition, though a few specimens of the younger stages are able to winter through. They are to be found in the winter in almost any situation affording shelter and often on warm days may be seen actively crawling about. With the advent of spring they gather on the opening buds and tender parts of the plants, and begin their work of destruction. Soon, too, they deposit their eggs, but where or how is not known; but at any rate, by the time the apples are in bloom we find the young bugs in all conditions on grass and clover fields. There are at least three broods of the bugs in a year, but the old bugs continue to deposit their eggs so long a time that the broods are not distinct, but bugs in every stage of growth may be found at any time during the summer.

The insect, as has been mentioned above, is supposed by both Riley and Harris to be poisonous to the potato and other plants, but as far as my observation goes, I am inclined to doubt it. The only thing I have seen to favor such a view is the turning black of the blossom buds on the apple and pear, but these would turn black naturally from any mechanical injury which would kill them. Is it not possible that in the case of the potato there was a bacterial or fungoid disease present, which was aided and disseminated by the insect?

REMEDIES.

It is very evident that an insect with such variable food habits will require different methods of combating it under its different circumstances. In the flower garden, and even in the nursery, it could be jarred from the buds in which it passed the night, early in the morning before it became active. This would destroy great numbers and control in a great measure the evil effects. The sluggish condition of the insect early in the morning may be the means of quite a successful warfare.

In other cases the use of pyrethrum and of kerosene have proved the most effectual. Pyrethrum is a plant that should be raised in every garden. It has a very pretty bloom and is quite ornamental. The leaves and flowers of this plant dried

and powdered make one of the best of insecticides. The powder should be kept in a closed vessel, as it rapidly deteriorates in the air and is much weaker after a few years, even if well closed. Pyrethrum powder may be obtained in most first-class drug stores, and is often sold under the name of buhach. It may be applied as a powder or made into a tea or as an alcoholic extract and diluted and sprayed on the plants. This is good for application to small fruits, as it is perfectly harmless and has practically no taste.

Kerosene is very effective against this insect and may be used either as a powder or as an emulsion. Like the pyrethrum it will be most effective early in the morning, as the insect is very active in the day time, and more likely to escape. The emulsion is generally made according to one of the following formulæ:

1.	Kerosene	2 gallons—66⅔ per cent.
	Milk	1 gallon—33⅓ per cent.
2.	Kerosene	2 gallons—64 per cent.
	Condensed milk—4 cans Water —8 cans	9 pints—36 per cent.
3.	Kerosene	2 gallons—66⅔ per cent.
	Common soap or whale-oil soap. ½ pound Water. 1 gallon	—33⅓ per cent.

Either fresh or sour milk may be used, but the latter is preferable if the emulsion is not to be used at once. The reason is that when sweet milk is used, it will in a day or two curdle so that the emulsion becomes thicker and harder, and requires stirring, while if sour milk is used, no further action occurs, although kept indefinitely. Where ordinary milk cannot be readily obtained the condensed milk sold in the stores may be used. It is ordinarily put up in cans holding exactly three-quarters of a pint. When soap is used, whale-oil soap is recommended, as it is a very good insecticide in itself, but common soap makes an equally good emulsion.

The process of making the emulsion is as follows: Heat the milk or the soap solution to about the boiling point and add at once to the oil. Now, by means of a force pump and spray

nozzle, churn the mixture for five or ten minutes, Upon cooling, if these directions have been followed the emulsion will be a white, glistening mass of about the firmness of butter. It will adhere to the surface of glass without oiliness and bear any amount of dilution with water without the oil separating from the mixture.

The above formulæ will give three gallons of the emulsion and must be diluted before using.

About one part of the emulsion to fifteen of water will give good results, but it must not be much weaker than this or it may not kill all the bugs.

The preparation of the kerosene powder consists in simply mixing, say, ten per cent. of the kerosene with any available powder, such as road-dust, flour, plaster, etc.

The use of kerosene powder does not seem to be attended with any risk of hurting the plant since I have used it with kerosene of the strength of 20 per cent. on a great number of plants, but have not seen the slightest trace of scorching.

On small fruits, such as the strawberry, when first applied, it gives the taste of the oil to the fruit, but I have been unable to detect any trace of it after a good rain, or after three or four days, even when there was no rain. I think, therefore, that it could be used on berries, though not perhaps as conveniently as pyrethrum.

The arsenical poisonings, of course, are not applicable to this insect, because of its living only on the sap of the plant.

SUMMARY.

The tarnished plant bug is widely and generally distributed, it lives on the sap of the tender growing parts of plants, causing at times a great amount of damage.

It lives upon almost all kinds of plants, proving the most injurious to various flowers and garden crops, especially to potatoes. In the nursery it stunts the growth of the young stock in the spring, and by killing the blossom buds prevents the trees in the orchard from bearing a full crop of fruit. Straw-

berries are caused to shrivel up and "button," and other small fruit is rendered less valuable on account of not being full and plump.

Its first or egg stage is almost unknown. As a larva it passes through three stages; at first green, and becoming more and more mottled, and having five characteristic dark spots at least in the last larval stage. The pupa is more mottled and has the rudimentary wings quite conspicuous. In the adult stage it is a very handsome and variable insect, about a fifth of an inch in length. The most characteristic mark is a white, more or less Y-shaped spot on the scutellum.

The winter is passed mostly in the adult stage and there are at least three broods in a season, though they are very irregular. Its injury is probably solely due to the mechanical effects of removing the sap, though supposed to be at least partly due to a poison inserted.

Three remedies are proposed as practical: 1st. Jarring from the tree in the morning while it is still sluggish. 2d. Pyrethrum, and, 3d, Kerosene. The latter to be applied as powder or in solution.

ARTICLE III.

THE CHINCH BUG. (*Blissus leucopterus Say.*) One of the curious things about insect ravages is the fact that it is seldom the larger insects that are injurious, but the smaller, often some of the very smallest, by their remarkable reproductive powers, are able to become so numerous as to do the severest injury.

The chinch bug is one of these. Its injury in bad years in the great grain growing States is not to be counted by thousands of dollars, but by millions. This State is seldom troubled by the pest, but since it has been more or less injurious the last two or three years in the northern part, demands for information concerning it, and the means of combating it have been made, in answer to which this article has been prepared.

INJURY IN ARKANSAS.

In Arkansas, the damage is mostly confined to the counties bordering on Missouri. The earliest account I was able to

obtain was from Mr. W. W. Bishop, of Springdale, Washington County. He writes: "The first chinch bugs worthy of notice made their appearance here early in the spring of 1874. The spring was quite dry when the corn was small and the bugs damaged it seriously. The corn in some fields did not obtain the height of three feet, and did not make a bushel of corn to the acre. There were localities where they did but little damage, and corn was raised in sufficient quantities so that people could get it by paying one dollar per bushel and hauling it fifteen to thirty miles. * * * The wheat was damaged by them to some extent, as was also sorghum and many other things." I have it from Mr. A. Tomlinson, of Berryville, Carroll County, that they appeared there the following year, doing considerable damage.

In the year 1874, it may be remarked, the chinch bug did an onormous amount of injury in Missouri, estimated by Prof. Riley, to amount to no less than $19,000,000, in that State alone. The bug extended into the southernmost counties, where it had not been known before, and it is only natural to expect that some of the northern part of Arkansas should suffer.

Since these dates the State has been quite free from its injuries until the summer of 1887, when it began to show itself in considerable numbers in the northwestern portion of the State. During this year great damage was also done by this insect in Missouri, but few of the southern counties escaping.

In 1888 the insect was more or less destructive all along the northern counties, except in the northeast, and this season it appeared in the same localities in great numbers, even threatening the entire destruction of certain crops, but timely rains inducing disease in the bugs over the whole region put a stop to their work. The following extracts from the correspondence of the office will show something of the amount of injury and its sudden stoppage:

Madison County.—"The chinch bugs were very numerous here. My wheat was covered and a great deal was killed, but as it was early it was not damaged as badly as it would have been if later. The damage was about two bushels per acre.

When the wheat was cut they commenced on the young fox tail grass, killing the most of it. They also moved out on the corn adjoining, and when I plowed my corn the last time ten or fifteen rows next the wheat stubble was covered from two to three feet from the ground. Some few stalks wilted down and were covered all over. I supposed that they would ruin my corn and went back in a few days to see how they were progressing, and found two-thirds of the bugs dead, and in less than a week they were all dead, not only in the corn, but the ground in stubble was covered with dead ones, and now it is a rare chance to find a live bug. Some claim that they had shed off and left, which is a mistake, for I found all sizes, from adult ones with wings down to the little red ones. They surely died from some cause, and I was truly glad of it. I have had some experience with chinch bugs in Kansas, having lived there nine years, and there were enough here this spring to have very nearly ruined the corn crop but for their lucky demise."

F. M. COGER, Huntsville.

Carroll County.—"Chinch bugs appeared in April, 1888, only a few at first, but increasing very fast, damaging wheat ten per cent., leaving it at harvest, they went into the corn, where they stayed till frost, doing a damage of ten per cent. In April, 1889, they were very numerous, doing much damage to wheat and corn till the first of June, when the hard rains destroyed or drove them away. There are very few now."

A. TOMLINSON, Berryville.

Newton County.—"The chinch bug did a considerable damage in June to the corn crop. I think they injured it fully one-sixth and the wheat crop fully one-half. At a close, correct and low estimate there was not more than one-half a crop of wheat through the County. The oat crop was also injured to a great degree, one-fourth at least, for there was in many places millions of chinch bugs on the wheat and oats. The corn crop has come out all right, however, so well, indeed, that there is as fine a prospect for corn as there has been for many years." GEO. M. CHAPMAN, Swain.

Stone County.—"They first made their appearance in this county last year, coming from the north and crossing White River. They did but little damage last year, seeming to put in their time in overrunning as much territory as possible. They promptly appeared this spring, and during a very dry spell, lasting four weeks, they did considerable damage to wheat and oats, but they had but a short time to get their work in, as harvesting commenced. They then gave their undivided attention to corn, generally, getting from ten to twenty rows into the corn from place of entrance, when happily the wet season set in, and they disappeared." WM. H. ROSA, Mountain View.

Fulton County.—"Last year, owing to the ravages of the chinch bug in connection with drouth in the latter part of the corn crop season, the corn crop was nearly a total failure in this section, not more than a third of a crop was raised. This year they were more numerous in the early part of the year than last year, and threatened the destruction of the wheat and corn crops. Wheat was seriously injured, but before they did much injury to the corn they disappeared, died, with the cholera we supposed, consequently our corn crop is the best we have had for years." S. W. COCKRAN, Union.

Sharp County.—"There was some complaint of the chinch bug in wheat, having ruined some crops. It is now in corn, but has done but little damage. * * * The chinch bug was here last year and damaged corn a little.

F. M. NESMITH, Evening Shade.

NAME.

This insect has had a variety of common names. In parts of North Carolina it receives the name, Hessian Fly or, Hessian Bug, on the supposition that they were left in the country by German soldiers, as they were first observed after a detachment had passed through. In Illinois, they were similarly called Mormon lice, upon the supposition that the Mormons were somehow responsible for them. The name, chinch bug, by which they are now everywhere known, is derived from chinche, a Spanish word, the name of the common bed bug.

DESCRIPTION.—The egg [Fig.6,F.] The egg of the chinch bug consists of an elongate oval, transparent and elastic shell, filled with a finely granular mass of yolk, which gives the color to the egg. When first laid, it is pale yellowish or whitish and translucent, but as the young bug develops within, it becomes brown or almost amber colored, and finally the markings of the forth-coming insect can be made out. Especially prominent are the red spots corresponding to the eyes. These occur at the upper end, or the one which last left the bug when being laid. This end is distinguished by being rather squarely flattened off and possessing four small, rounded elevations. When freshly laid, they are about 0.03 of an inch in length, but like the eggs of quite a number of other insects, it increases in size while developing. This increase is due almost entirely to the absorption of water, but a little may be due to air taken in at a small hole which is left in the shell at the upper end, and is known by the long name, micripilar pore, With this kind of egg, moisture is as essential to its development as it is to the germination of a seed. This peculiarity of the egg of the chinch bug may be a partial explanation of the observed fact that extremely dry weather about the time the brood comes to maturity is followed by a decrease in numbers of the next brood.

The first larval stage.—Upon hatching, the chinch bug is a pale yellowish green, oval creature, with the eyes and two spots on the back reddish. The joints which compose the body are almost all the same length, and the feet have but two joints. As it grows older, it becomes pinkish or almost red except the fourth and fifth joints back of the head which remain lighter.

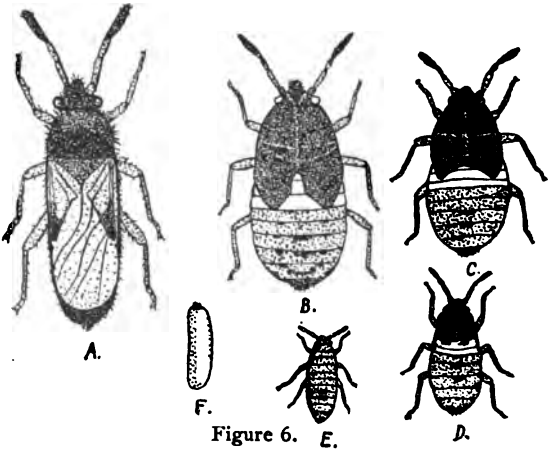


Figure 6.

The second larval stage.—After changing its skin, [Fig. 6, D] the head and part of the thorax become dark colored. Beyond these, there are two joints almost white, and the rest of the body is red with a couple of darker patches on the middle of the back of the abdomen. The three joints composing the thorax are no longer the same length, but the first has become the longest and the second the shortest.

The third larval stage.—In the third larval stage the wings begin to be distinctly visible, [Fig. 6, C] as slight backward projections from the second and third thoracic segments. The colors are much the same as in the second stage, but not so bright.

The Pupa.—The colors in this stage, [Fig. 6, B] are still duller and darker than in the last, and much more resemble those of the adult. The shape is still broad and flat like that of the larva. The wing pads are quite large and partly cover the two pale abdominal segments.

The Imago.—The adult insect, [Fig. 6, A] is rather long, slender, blackish and somewhat hairy. The antennæ are four jointed, the last dark and longer than the others, which are yellowish. The legs and beak are also yellowish. The prothorax is dark, almost black towards the back edge. The elytra are white with the veins and a spot about the middle of the outer edge of each black. Beneath the body is nearly black.

VARIATION.

The above description has been made general enough to cover most of the variations of this species. All insects vary more or less and the variations of this one mostly in color are very considerable. The younger stages are often of a sombre brown, and all shades between this and a brilliant vermillion exist. The latter color especially in the older larval stages, when contrasted with the white band and the darker anterior parts, is very characteristic. The pupa varies in a similar manner, but it is always much darker than the larval stages and never bright red. In the adult insect the variation is so much that Fitch and Riley have given names to some of the more conspicuous forms, as follows:

Albivenosus Fitch—Elytra white, without black marks, except the marginal spot.

Apterus Fitch Wingless—Elytra shorter than the abdomen.

Basalis Fitch—Basal joint of the antennæ dusky and darker than the second.

Dimidiatus Fitch—Basal half of the thorax deep velvety black, anterior half grayish.

Femoratus Fitch—Legs pale, livid yellow, the thighs tawny red.

Fulvivenosus Fitch—The veins on the elytra, tawny yellow instead of black.

Immarginatus Fitch—Basal margin of the thorax not edged with yellow.

Melanosus Riley—Elytra dusky, with black markings at base, and tip of body black.

Nigricornis Fitch—The two first joints of the antennæ blackish.

Rufipedis Fitch—Legs dark, tawny red or reddish brown.

LIFE HISTORY.

In the spring the chinch bug comes forth from its retreats and begins to feed on any convenient food plant, flying freely and so probably spreading widely. They copulate and lay their eggs near the roots of grains and grasses. In about two weeks these hatch and the young bugs commence to feed at once on the plant upon which they find themselves. Often they pass through their whole development on the plant upon which they found themselves, but often through scarcity of food they are compelled to migrate to other plants. When on wheat they are generally nearly or quite mature at harvest and at about this time they leave the wheat and migrate in great numbers to the adjoining corn fields and meadows. Here the eggs for the next brood are laid on the grass near the roots or under the sheathes of the corn leaves, and the young bugs generally live in these situations till they have attained considerable size. They do not have occasion to migrate in masses like the first brood on the small grains.

HIBERNATION.

The adult chinch bug passes the winter in any sort of a shelter it can find, such as beneath loose bark, among fallen leaves, under stones, in cracks of fence boards, in all sorts of rubbish, and in corn stalks, beneath the sheathes and in the husks. Their powers of endurance are something remarkable, as I have seen them repeatedly in situations where they became thoroughly wetted, and frozen in this condition, but when warmed up were as lively as ever. The young may be able to pass the winter in this State, as I have found them alive as late as January, but as a rule it is the adult that passes the winter.

NUMBER OF BROODS.

The spring brood comes mature about harvest, but they are at this time very uneven, that is, almost all sizes may be found at this time, and this is a fact for the remainder of the year. It is, therefore, rather difficult to say how many broods there are, but as the bugs will, in some circumstances, lay eggs within a week from the time they become adult, and as it takes but six weeks for the bug to become mature, it is evident that the young bugs found in the fall are probably the third brood. I do not mean to say nor do I believe that three broods is the rule, even as far south as Arkansas, but that we have a small, third brood, I think there can be no doubt.

HABITS.

One of the most interesting of the habits of the chinch bug is the harvest migration. This often occurs before the grain is cut, and is often delayed till afterward. The insect, moved by a common influence, leaves the plant on which it has been feeding, descending to the ground, moves forward with its fellows towards the adjoining fields. I have seen them so thick as to entirely cover the ground. Their motion is not rapid, and often a steady stream is kept up for several days. Coming into the corn field they cover every stalk several layers deep. A little later they some times take to their wings and fill the air, but there is no regular migration for they fly in all directions and

scatter everywhere. This only occurs, as far as I know, when they are excessively numerous, but in the fall and early spring they are quite frequently on wing, even when not numerous.

FOOD PLANTS.

The chinch bug seems to feed on nothing except plants belonging to the grass family, though they are said to have been observed feeding on wild buck wheat, but it has not as yet been confirmed by other observers. One of my correspondents, Mr. F. M. Nesmith, of Evening Shade, Sharp County, mentions their presence in large numbers on cotton, but whether they were really feeding or not is not known.

Among the grasses of course the damage to wheat and corn is the most severe, though the meadows and other grain crops are often ruined by them. As far as known, it may be said that the chinch bug feeds on all of our native and cultivated grasses, but showing great preference to certain kinds.

EFFECT OF WEATHER.

Much has been said and written about the relation of weather to chinch bug prevalence, and a certain very important relation certainly exists. It seems to be a well observed fact that dry years are apt to be chinch bug years and wet ones not. To cause a serious injury, there must be at least two successive dry years, and the attempt has been made, particularly by Prof. Thomas, of Illinois, to demonstrate a definite periodicity in the amount of rain fall, and in this way be enabled to predict years of chinch bug injury and immunity. It certainly presents an interesting field for inquiry.

Why wet weather should be inimical to the development of chinch bugs in excessive numbers was attributed years ago (1867) by Dr. Shimer, to a disease which it induced. His views may have been vague, and were at the time ridiculed by tthe best scientific authority, but the investigations of the last few years have proven his theory to be in the main correct.

NATURAL ENEMIES.

Bugs, as a rule, are remarkably free from the attacks of

other insects, probably on account of the substance they secrete that gives them such a disagreeable odor. The chinch bug, as far as known, has no parasite preying upon it. The insects which have been observed feeding on it, considering how well it is known, are very few indeed. A few species of coccinelids or lady birds, the larva of a lace wing fly, an ant and a ground beetle make up the whole list, and there is no reason to believe that these destroy them in any large numbers, but rather it is probable that they only eat a few as a last resort rather than starve.

Among the vertebrates, the frog and a small number of birds eat them occasionally. The quail seems to eat more than any other bird, but it is very doubtful if all these natural enemies combined can have any perceptible effect in diminishing its numbers.

DISEASES.

Although the chinch bug is so well protected from natural enemies it appears to be especially susceptible to the ravages of disease. At least three kinds of diseases are known to produce epidemics among them. One is caused by a microscopic plant. *Micrococcus insectorum Burrill* which infests parts of the digestive tract and is allied to the germs which produce the contagious diseases among human beings. Under the proper conditions it is extremely contagious and fatal. The plant is about the shape of the letter O, and so small that it would take 25,000 of them placed end to end to make an inch in length. They multiply by simply dividing into two equal parts, which soon grow to full size and are again ready to divide. This is their whole life history.

A second disease is caused by a plant belonging to the genus *Botrytus*. It is a plant of this genus that gives rise to disease in the silkworm called muscardine. This fungus is in the form of long slender threads which penetrate in all directions through the tissues of the body of the insect and causes its death. After death the insect becomes dry and stiff and the fungus sends out over the surface what seems to be mould, and

indeed this plant is quite closely related to the moulds. This powdery efflorescence is produced by the threads within the body sending out branches which penetrate the skin, branching freely and being divided at the ends of its branches into numbers of oval spores which produce the powdery appearance.

The third chinch bug disease is caused by another thread like fungus belonging to the genus *Empusa*. This lives within the body of the insect as does the *Botrytus* and is about equally fatal. After death a similar though more profuse covering of white down is observed. Bugs dying of this disease almost always remain attached to the leaf on which they expire making the leaf look like it was covered with spatterings of flour.

All three of these diseases seem to have been with us the past season and I cannot say to which we are most indebted for the happy demise of the bugs.

REMEDIES.

Great numbers of remedies have been proposed, some useless and others too expensive to be of practical value. I do not intend to give here a resume of them all, but to present those that are best and most applicable here.

Prevention is always better than cure and especially so in fighting insects. Chief among preventative measures is good farming, crops properly rotated and diversified, good clean cultivation and the proper use of fertilizers will produce crops that will best stand the attacks of the chinch bug.

Every farmer should keep himself informed of the condition of the chinch bug by making careful examination for it each winter in places where they are known to hibernate, for this will enable him to know what years to expect and what years he need not fear them. It is not safe to plant much wheat and corn if the bugs are hibernating in great numbers but the crops must be as much as possible those not belonging to the grass family. On the other hand if there are but few bugs and especially if the year before has been a wet year wheat and other grains can be sown without fear of the bugs.

If the bug is threatening it will do a great amount of good

if the farm is given a thorough cleaning in the winter. All rubbish should be raked up and burned especially from fence corners and hedges. The more thoroughly this is done the more satisfactory will be the result.

After the insect has attacked a crop hardly anything can be done. At the time of the harvest migration there are quite good means of killing them and preventing them from destroying other crops. One that is quite successful is to cut about six rows of corn next to the wheat field when they begin to migrate and plow up the ground leaving a double furrow in the middle in which are laid the stalks that were cut. Under these the bugs will congregate in great numbers and not attempt to pass them. As soon as they are dry enough they should be burned which will destroy the bugs. Kerosene emmulsion prepared as described in Article 2. and sprayed on the bugs as they attack the outer rows is a very simple, cheap and effectual remedy.

It has been suggested that when the bugs suffer from epidemics like that of last summer, the dead bugs should be collected in large quantities and carefully dried and put up in paper bags and stored in a dry place till the bug becomes destructive again, when they may be scattered over the fields and start the diseases again. This method has not been tried but I see no reason why it may not be valuable.

INSECTS MISTAKEN FOR CHINCH BUGS.

There are a number of insects often mistaken for chinch bugs but they do not resemble them much and may be readily distinguished from them as follows.

The false chinch bug [*Nysius angustatus Uhler*] by having the head as wide as the body.

The insiduous flower bug [*Triphleps insiduosa Say*] by being much shorter, wider and flatter, the color is generally also a light brown.

The ash grey leaf bug [*Piesma cinerea Say*] by having no white on the wing covers and being flatter and of quite a different shape, and

The flee negro bug [*Corimelaena pulicaria Germ*] by its round shape and its uniform black shining color.

SUMMARY.

The chinch bug has been long known and is a widely distributed insect. It did considerable damage the past season in the northern part of Arkansas and it appears in this State only as the outposts of extensive invasions in Missouri.

The egg is a yellowish white elongate oval body which increases considerably in size before hatching. The young bug is reddish and becomes darker as it grows older and has a conspicuous white band across the middle. The adult insect is slender, nearly black with white elytra. It is quite variable.

The egg laid in the spring near the roots of grasses produce the first brood which becomes mature about harvest. Those in small grain then migrate to adjoining fields where they spend the rest of the summer. In the fall they seek places to pass the winter which they do mostly in the adult condition and prove themselves very hardy. They migrate at harvest on foot but may use their wings for this purpose later. Their food is chiefly if not entirely grains and grasses.

Wet weather seems to be inimical to them and though they have hardly any natural enemies they seem to be particularly susceptible to disease. As [defensive measures, may be mentioned good farming, planting of crops upon which they do not feed when they are threatening and in addition to this a thorough winter cleaning. In the summer barriers to prevent fields being invaded, and the use of kerosene emulsion is recommended. It is further suggested that dead bugs be preserved to induce the diseases another year. Various insects are often mistaken for chinch bugs but can be easily distinguished.

ARTICLE 4.—THE COTTON WORM.

We intend to make a special study of the cotton worm the coming season, and desire the co-operation of the enterprising farmers throughout the State and of the States south of us. We invite your careful perusal of this article where we have attempted to present a concise account of the present state of our

knowledge concerning the insect, the remedial measures for combatting it and to show particularly the points on which more light is needed, and where careful observation may produce valuable results.

The farmers of this State lose a great amount every year through the ravages of this insect, and what is worse, the amount of damage seems to be steadily on the increase. It looks as though our farmers would soon have to arouse themselves to take more active measures to defend themselves or to accept failure as the only alternative. It is not enough that remedial measures be used in a blind, hap-hazzard sort of a way, but they must be chosen and applied in accordance to the dictates of good common sense, and after a careful consideration of the subject in all the light that science and experience can throw upon it. An encouraging sign of the times is the convention at Alma, that was called for the purpose of declaring war upon this insect foe and planning a campaign against it.

HISTORY.

It is quite likely that the cotton worm was originally a tropical insect, perhaps a native of Central America. The first recorded instance of its appearance within the United States was in 1793, in Georgia and South Carolina. In 1800 the same region suffered again, but after that it was unknown for nearly a quarter of a century. Louisiana suffered in 1814 and again in 1825. The latter year seems to mark the time when the cotton worm actually got a firm foothold in this country. It was not only destructive in Louisiana, but appeared in destructive numbers in all parts of the cotton region and since then we have never been free from its destruction, at least, in some part of the cotton region. In 1838 they were very destructive, and 1840 is their first recorded apppearance in this State. From 1844 to 1847 they were especially destructive, but after that they did only local injuries till 1866, in which year this State suffered a loss greater than ever before. Another heavy loss occurred in 1868. Since that time the worm seems to be getting more and more destructive, but not in a regular ad-

vance, but in sort of waves. As years of the greatest and most general losses might be mentioned 1873, 1876 and 1881.

DISTRIBUTION.

Wherever cotton can grow, the cotton worm can live. The insect is a native of this country and is not found outside of the American continent and the adjacent islands. Within these limits it occurs everywhere cotton is grown, with the possible exception of California and Southern Brazil, but I have no doubt that in time we will hear from it in those localities also. This wide range is due to the migratory habits of the moth, which is sufficient to extend it much further if cotton, the only food plant of the worm, was cultivated further north. In the fall the moth is taken in all parts of the Northern States, and there is on record, the capture of the insect, even as far North as Quebec.

NAME.

The insect is known by a variety of common names, the "cotton worm" being the one most used, but "army worm," "cotton army worm," "caterpillar," "cotton caterpillar," are all more or less frequently heard in about the order named, according to my experience. Of course all will see at once the desirability that it always receive the same name, so the use of any other than cotton worm should be discouraged.

Scientifically, it is now known as *Aletia xylina Say*, having been first described by Thomas Say, in 1830, and called by him *Noctua xylina*. Since that time it has received a number of names by various authors, and been placed in a number of genera.

DESCRIPTION.

The Egg:—The cotton worm like almost all other insects, comes from an egg laid by the moth, but this stage is nothing but a myth to a majority of farmers. I do not think one out of a hundred is really sure he ever saw one and the majority of those that think they have, probably have only seen the common plant louse, a small pale green or yellowish insect living

mostly on the underside of the cotton leaves. The real egg is a flat disk of about a fortieth of an inch in diameter and of a bluish green color, looking almost blue as compared with the brighter green of the leaf. When examined with a microscope it will be found to be beautifully ribbed as shown in Fig. 7.

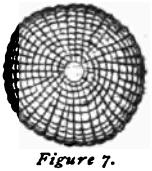


Figure 7.

The Larva :—This is the stage best known to every one for it is during this stage that all the injury to the cotton is done. During this condition the cotton worm moults or sheds its skin four, or generally five times, so that there are really five or six larval stages but they are hardly distinguishable from each other save by size. The first larval stage, or that before the first moult, (Fig. 8) forms an exception to this statement. The worm when first hatched, is not marked like the older worms but is of a pale, dirty yellow color with minute black elevated spots from which arise small black hairs. After moulting, the larva assumes the characteristic color and markings of the mature worm. This is very variable and consists of a ground color of various shades of rather light green, in which are traced five very narrow definite whitish lines. One of these is straight and occupies the middle of the back while on each side are two lateral lines shown in Fig. 9, of a more or less wavy character. On each side of the median line the space is shaded with brown or sometimes jet black, and between the two lateral lines there is usually a shade of brown sometimes quite dark, but never approaching the darkness of the shading on the back. In the spring the majority of the worms have these shades quite light, while in the fall the reverse is true. This difference is so conspicuous that each spring there is considerable discussion whether the worms we find are the real cotton worms or not.

Figure 8.

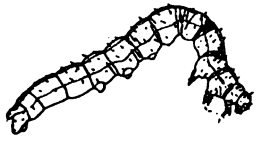


Figure 9

The Pupa :—When full grown the worm prepares to enter the pupa or chrysalis stage by wrapping themselves in a cotton leaf, fastening it around them by means of silk threads which it secretes. This process is known as webbing up. After mak-

ing this preparation the worm loses the use of its legs, shrinks considerably in size, and by a final moult revals the pnpa, Fig. 10. It is at first very delicate and almost white, but it takes but a short time to become hard and firm and of the beautiful rich brown so common in pupæ. While in this stage the insect has no power of motion beyond the ability to bend back and forth the pointed end of the body. At this pointed end there is a peculiar set of six hooks which catch in the silk and hold the insect in place.

Fig. 10.

The Imago:—In the adult, or imago condition, Fig. 11, the insect is a moth measuring from an inch to an inch and a half from tip to tip of the expanded wings. In color it is a brown, varying from almost a yellow to a deep olive brown and often has a purplish cast. It is marked by having on the front or upper wings three or four indistinct wavy lines of darker color, a conspicuous dark spot about the middle of each and a row of very small white spots, one at the shoulder and the others on a line with the dark spot dividing the space into three nearly equal parts. The under wings are of a uniform color. The male is somewhat smaller than the female and is further distinguished by the abdomen ending rather bluntly instead of being extended into a sharp point.

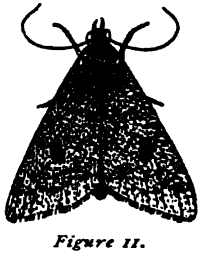


Figure 11.

LENGTH OF LIFE.

The length of life of insects is always a matter of considerable variability and this is especially true of those insects, like the cotton worm, having several broods during the year. With the cotton worm the egg stage lasts perhaps on an average, three or four days when the conditions are favorable, but it may be two or three times that number when the weather is cold. In this State as the insect is not here till well on towards summer, the time is probably seldom longer than six or eight days. In the fall, if the insect is overtaken by the frost in this condi-

tion, it is sure never to hatch. The larva stage may last only a week, or in unfavorable conditions three or four times that length of time. The average in this State, according to my observations, is from ten days to two weeks. Frost is quite fatal to the insect in the larval stage. From the time the worm webs up till it appears as a moth is about two weeks on an average in this State, though in very favorable circumstances, it may appear in one week, and it has been known in very unfavorable conditions to require a month. The pupa cannot stand frosts much better than the earlier stages.

The cotton worm spends the longest part of its existence as a moth. After emerging it ordinarily begins depositing its eggs in about three days, and can keep it up a month or more. The moths produced late in the fall do not commence depositing till the next spring. The moth is the only stage of the cotton worm which can stand the rigors of winter, and even it cannot stand too much cold.

Just about a month elapses on an average from the egg condition until that stage is reached again, and as the cotton worm invades this State often as early as June, we may have as many as four or five broods. They do not, however, form really distinct broods, as at almost any time they may be found of all ages and sizes.

HIBERNATION.

Many questions have arisen concerning the hibernation of this insect and numbers of conflicting hypotheses presented to the public. The favorite idea seems to be that the pupa lives over winter, either in the stalks or in the ground, and numerous preventive measures have been used on this hypothesis. As has been already stated, the moth alone is enabled to pass the winter, and it is still further certain that even in this stage the insect can pass the winter only in the more southern part of the cotton region. It can be confidently asserted that in Arkansas the entire lot of cotton worms, in all their stages are killed each winter, so that as far as this State is concerned, the cotton worm does not hibernate at all. This fact has a very important bearing upon the methods of treatment, as will be shown further on.

MIGRATION.

That the cotton worm moth is a strong flyer, may be known from the fact already stated, that in a single season it has made its way from the southern portion of the cotton region to even as far north as Quebec. This migratory habit is not confined to occasional individuals, but great swarms of them go to a great distance from their breeding grounds. It is on record that the cotton worm moth was so abundant as far north as Wisconsin as to ruin acres of canteloupes by puncturing them with their rasp-like proboscis. These facts make it not so surprising that they should be able to so overrun this State each season. Another point of great economic importance is that this insect, like other migratory insects, is not normally of this migratory disposition. It is something that is induced by hunger. It is the larva that has to hunt some for its food that produces the moth of the roving disposition. It is a well observed fact that the cotton worm does not spread to amount to much, unless in some place it has been abundant enough to seriously rag the cotton. Though there may be millions of cotton worms in Louisiana, Mississippi and Texas next spring, if they are prevented from becoming destructively numerous in every part of those States, we, here in Arkansas, may never have a fear of the insect. It is a fact that we should thoroughly understand, that Arkansas only suffers from the cotton worm through the carelessness of our more southern neighbors.

LIFE HISTORY.

After passing the winter in some sheltered situation, the moth comes out as soon as it is warm in the spring, feeding on a variety of sweets, and searching for a place to deposit its eggs. This it finds on the rattoon cotton, and there the first brood of worms are nurtured. Some of the moths may be able to live till the new cotton appears, but most, if not all, are dead long before. After this brood there are two or three broods before the insect has increased enough to have stripped the cotton in spots, and therefore, to have attained the migratory habit. When the worms have succeeded in stripping the cotton, the resulting

moths spread far and wide, and it is the eggs laid by these wanderers that the first Arkansas brood is produced. From this time on till frost, recruits are continually being received from those States, and those that are here increase with wonderful rapidity, till soon we have to apply the poison or suffer the consequences. In the fall death puts in its work in a manner unparalelled among the larger animals, and except in a more favored, or perhaps I had better say, less favored localities, the cotton worm, in all its stages, is a thing of the past.

REMEDIAL MEASURES.

The peculiarity just mentioned gives us an advantage in fighting this pest that we have in hardly any other insect. Nature once a year confines the cotton worm in comparatively narrow limits, and it only remains for us to perfect methods for destroying it there or of keeping it within those limits. If we fail one year to keep it within bounds, it will present the next sason no more difficulty than before, on account of the area infected being the same. While we are solving that problem, we must have a means of defending ourselves after the worm has attacked us. Remedies may, therefore, be classed into two groups. One group would include the means of fighting it in its permanent region, and of reducing its numbers there, and in this way preventing migration, while the other group would include the means of fighting it after it has spread to the temporary region.

THE PERMANENT REGION.

The first thing to be done is to define, to make out with certainty, the limits of the permanent region. This was roughly done by the United States Entomological Commission for the States south of us, as follows: "Beginning with Texas it includes the region south of the Hanesburg & San Antonia Railroad, excluding, perhaps, the extreme western portion, but extending somewhat further north along the river bottoms. In Louisiana and Mississippi it includes the valley of the Mississippi river, with uncertain northern limits." This region must be accurately defined, for it is as essential to the success of

remedial measures, that we know where as it is to know what to apply.

This region, of course, is not absolutely fixed, for it will naturally vary from year to year, as the temperature and other conditions vary, but by careful observation for a number of years, and the careful study of the causes which affect it, it can be very accurately made out.

MEANS OF DEFINING PERMANENT REGION.

In the permanent region, the moth may be found alive in the winter, and wherever the moth is found successfully hibernating, must necessarily be within the permanent region. It is to this point that I would have planters in the States of Louisiana, Mississippi and Texas give their closest attention this winter. Look in all sorts of secluded places, in gin houses, barns, cribs, etc. Under the scales of the bark of pines and other trees, in short in any place where it could find a convenient hiding place. It is not enough to find the moth, but it should be sent to some one of enough scientific knowledge to determine beyond any question of doubt, whether the moth found, is the real cotton worm moth, for there are a great number of moths that look very much like the cotton moth, to be found in the same situations. I will be glad to have the specimens sent to me, and I would earnestly urge any one who has any interest in the matter to make careful search and communicate with me.

In the spring, as soon as it has begun to get warm, or even during warm spells in winter, the moth may sometimes be found flying, especially about dark, in search of food, in refuse heaps, where fruit has been thrown, or about flowers. As said before, the moth must be caught, and the question of its identity established beyond doubt, to be of any value. Bait traps, like those described further on, might be used, or sweets simply exposed on a plate, and visited each evening, when the moth may be expected out.

Another way is to search for the first brood of worms. This may be facilitated by growing a few plants in boxes in the

house, or in hot beds before it is warm enough to grow them out of doors. Expose these each warm night, and the moths will consider it a capital place to lay their eggs on. If all the rattoon cotton is destroyed about the place, you will be more certain to entice the moth. In this way you should have a brood of worms, if within the permanent region, before the cotton in the fields is up. The identity of these worms should be carefully made out, as were the moths.

If the three methods outlined above are pursued by a large number of planters in those States, there is no reason why we cannot make out very accurately the boundaries of the permanent region. This is a matter of importance, not only to those living in the permanent region, but to all whose cotton is threatened by the cotton worm. Let the cotton planters of this State, by letters and other means, aid in solving this problem. Let us write to our friends in Texas, Louisiana and Mississippi, calling their attention to the above and requesting that they make these observations and report to me.

REMEDIES IN THE PERMANENT REGION.

The various means of destroying the cotton worms in the permanent region may be very naturally divided into three classes. The first we may call the winter treatment. It includes all those schemes which has, as the object in view, the destruction of the hibernating insect. The second or spring treatment includes those directed against the first brood of worms and before the cotton worm has attacked cultivated cotton. The third or summer treatment includes the methods of combatting the insect after it has attacked the growing crop and is applicable in most particulars to the temporary region as well.

WINTER TREATMENT.

In the winter the moth is the only form of the insect alive so that any kind of treatment of soil or stalks intended to kill the egg-worm or pupa, is worse than useless. The clearing up of rubbish about the farm in winter may have a good effect in killing moths that may be hiding there, but its utility for this

purpose is very doubtful. The use of baits or traps to kill the moth in the warm weather of winter or in the early spring, ought to be attended with good results. A large number of devices have been invented for this purpose, but the allurement has always been either a light or a bait of tempting food. My experience with light traps has not been very encouraging, but I anticipate much better results with baits. As to what baits will do best, I cannot say, as the matter is still one of experiment, but the mixture of molasses and stale beer is very attractive to most moths, and it seems to be equally so to this insect. I would be glad to receive accounts from all who try various baits as to their relative merits. Bait traps will be made much more effectual if a little poison, such as Paris Green or London Purple, be added to the mixture, as otherwise only those that are unfortunate or greedy enough to fall in are killed, while with the poison added all that taste die. [Methods for making the light and bait traps, will be found in Appendix 2.]

SPRING TREATMENT.

The fact that the cotton worm has one brood of worms before the regular cotton crop is up, is one of the most encouraging points in the life history of this insect, and this brood is the place where the insect can be best attacked. As the insect lives only on cotton, if we can destroy all rattoon cotton throughout the permanent region, and, at the same time, delay the planting of the regular crop till all the moths are certainly dead, we will simply starve it out and be free from it till we have received a fresh stock from Cuba, Mexico or Central America. The destruction of rattoon cotton, even in a limited district, can but have a beneficial result, and should be practiced by every planter in the permanent region.

The starvation method cannot, of course, be wholly satisfactory, on account of the difficulty of being certain that absolutely all of the rattoon cotton has been destroyed and the need of late planting in connection with it. There is another method that seems to be without these defects. It consists in the same thorough destruction of the rattoon cotton, but of

providing a convenient place for the moth to deposit her eggs. She will, if a suitable place is found, lay all her eggs and probably die before the cotton sown at the ordinary time, is up. This may be accomplished by forcing some plants in a hot bed or in the house as already described and thus having ready for the moth a place which she will prefer to the rattoon, even though there should be a few plants that have escaped destruction. The worms should be carefully destroyed on these plants before they come to maturity, which may be easily done by dusting with London Purple or Paris Green. It is my conviction that if this method would be conscientiously pursued all through the permanent region, the cotton worm question would be solved and the hundreds of thousands of dollars now annually destroyed by these creatures, would be saved.

SUMMER TREATMENT.

Under this head will go the great mass of the remedies which have been used against the worm. It seems to be only at the time when an injurious insect is doing its greatest damage and when it is hardest to combat successfully, that the average farmer will think it worth his while to attempt to destroy them, but then he seems often willing in order to save only a portion of his crop to spend time and money enough, which, if used at the right time would have saved it all. To hit the worm when it is down may not seem charity to the worm but it is to the farmer. Many of these remedies and methods are applicable to the treatment of the worm in the temporary region, but we will discuss them fully here and when we deal with that region will only indicate the modifications necessary for the different conditions. For convenience in treating we will divide the remedies into the following classes: Methods for the protection and encouragement of the natural enemies, trapping the moth, confining the worms to limited areas, and the application of insecticides.

NATURAL ENEMIES.

There are a great many enemies to the cotton worm. Among the vertebrates all insectivorous birds, both domestic

and wild, prey upon them. Turkeys, chickens and geese should be raised in greater numbers throughout the permanent region, and beside their value in killing the worms, they will not be found an unprofitable crop. The shooting and trapping of small birds and the collection of nests and eggs should be prohibited, while the destruction of hawks and other birds of prey should be encouraged. Lizzards, frogs and toads devour large numbers of the worms and should never be wantonly destroyed.

The planter should familiarize himself with the insects which feed on the cotton worm and never allow them to be destroyed. Many kinds of wasps use the cotton worm as food for their young and their nests should be respected. Ants destroy large numbers of the worms; Prof. Riley has even advocated leaving stumps in the fields to serve as secure nesting places for them. Almost all the beetles seen about cotton fields are either kinds that prey on the worms or are entirely innocuous so the class as a whole should be preserved. Quite a long list of true bugs have been observed to prey upon the cotton worm. They are next to the ants in importance on account of the numbers they kill. Among flies only a few species of the family of robber flies are beneficial in this respect. These are the long hairy flies which make such a peculiar loud, buzzing noise when they fly. The mantis, often called Devil's horse or other similar names, feed upon the worms. Lace wing flies, ant lions and dragon flies are more or less beneficial in destroying the worms, and the insects of the latter group feed also on the moths.

There are at least a dozen species of insects known to be parasitic upon the cotton worm but no practical way has been yet suggested for protecting them. Larvae when picked by hand might be thrown in a barrel that is covered by a wire screen which will allow the parasites to escape but confine the moths, but the practical value of this is quite doubtful. If however a practicable scheme could be devised for keeping a large number of these parasites alive over winter to be turned loose in the spring good results should be expected.

MECHANICAL DESTRUCTION.

Hand picking is the simplest method of destroying the worms, but altogether too expensive to be of practical value. In the early part of the season the worm should be destroyed in this way whenever seen, and field hands should be encouraged to do so. A number of devices have been invented for knocking the worms from the plants, and destroying them, and I will here give the one that seems to be the simplest and most practical. For a beater, use a piece of cotton bagging that will reach across a number of rows. This is simply drawn over the top of the cotton by a cord fastened at each end, and pulled by a couple of men on foot or on a mule. Now take other pieces and place them between each two rows covered by the beater. They may be held straight, by a short rod fastened along the front end of each, and pulled along with the beater by attaching them by means of cords to a rod or rope, held taut between the two, pulling the device. The pieces drawn on the ground should be thoroughly saturated with kerosene, and all worms coming in contact with it will be killed.

TRAPPING THE MOTH.

The method of alluring moths to their death by lights or baits has been already described under spring treatment. It is most useful in the early spring, and from that time their value, from a practical standpoint, decreases till the fall, though a larger number than ever of the moths may be killed, the value is almost nothing, for it is probable that not one in a thousand of the moths killed at this time would have lived over winter anyway.

CONFINING THE WORMS TO LIMITED AREAS.

These measures, are as yet, more theoretical than otherwise, as they have not been practically tested. There seems, however, no reason why they should not be eminently successful. They consist in planting varieties of cotton in limited areas that are more attractive to the moth than the ordinary kinds, and in this way cause the moths to deposit their eggs chiefly on these places. Cotton might be easily improved by selection in

this particular, and it needs no argument to show that if the whole plantation can be protected by the careful poisoning of a few small patches a great saving is effected. In poisoning, it is just as easy to kill ten or twenty worms to the plant as it is to kill one.

APPLICATION OF INSECTICIDES.

An extensive and very thorough study of the various insecticides to determine their applicability to the destruction of the cotton worm were made by the U. S. Entomological Commission, and those who desire to learn about all those tried are referred to their Fourth Report, Chapter X. Two insecticides, or rather classes of insecticides, were found by them to be practical and effectual against the worm. These were kerosene oil or crude petroleum, made into an emulsion in the way described in article 2, of this report, and the application of some of the arsenical poisons. The oil has the advantage of being perfectly harmless to man, though deadly to the insect, but it is rather more expensive and troublesome to apply. It is applied as a spray by the method described below for the poisons, and to be the most effectual it should be thrown on the plants from below. It will only kill those that it comes in contact with, and therefore, is immediate in its action. The poison, on the other hand, does not kill by contact, but must be eaten by the worm and protects the plant as long as it remains upon the leaves.

ARSENICAL COMPOUNDS.

White arsenic and other soluble forms of arsenic are much more likely to scorch the leaves of the cotton and to cause the dropping of the squares and the young bolls, and though somewhat cheaper, have been almost entirely superseded by the less soluble forms, London Purple and Paris Green. The former has fifty to sixty per cent of arsenic in it, and is chieffly an arsenate of copper, while the latter has forty to fifty per cent of arsenic in the form of arsenate of lime. These are often more or less adulterated, so that care must be had in buying of responsible parties. As to the comparative merits of these two compounds, there is a great amount of difference of opinion.

It is probably a fact that London Purple is more apt to scorch the leaves if incautiously applied, but if care be had in this particular there need be no trouble in this line. The cheaper price at which it can be bought, of course, gives it a decided advantage.

METHOD OF APPLICATION.

The poison may be applied as a powder dusted on the plants or it may be sprayed on, mixed up in water. The former way requires the use of more poison, a pound generally going on a little over an acre, while with the improved methods of spraying it may be made to cover nearly five times as much. Dry poison is certainly less apt to injure the plant, and in rainy weather will stay on the plant longer. Each one will have to decide for himself which is for him the best and cheapest. It has been the practice to dilute the poison when used dry with any convenient powder to insure uniform application, but it has been found that it can be applied about as well pure. A certain amount of dilution, however, with some material that will make it more adhesive in wet weather may be desirable. Some experiments made at our Pine Bluff station, an account of which will be found in Appendix 3 of this artice, shows something of the value of flour for this purpose. A method of applying the powder which is much practiced in this and neighboring States, consists of putting the poison in sacks of closely woven muslin tacked to the ends of a pole which is carried in the lap across the back of a mule so that the sacks hang over the two rows of cotton. Striking the pole against the saddle is sufficient to sift the fine powder on the plants and the poisoning is accomplished by simply riding up and down alternate rows. This is rather an expensive way of applying the poison when large fields are affected, and many have adopted the Roach machine, made by the Roach Manufacturing Co. of Vicksburg, Miss., which scatters the poison broadcast by means of a blast. With this machine, one man can poison a hundred acres a day and in a very even and satisfactory manner. For spraying, I know of no simple contrivance that is satisfactory, but numbers of machines have been invented that will do rapid work in a thorough manner. For an ac-

count of them and the plans for construction, I must refer the reader to the fourth report of the U. S. Entomological Commission.

THE TEMPORARY REGION.

Within the temporary region the same remedies may be used as for the summer treatment of the permanent region, but we have by no means the inducements for carefully and continuously fighting the cotton worm that they have in that region. If the cotton worm question is to be solved, it must be in the permanent region. All that it is worth attempting to do in this State is to defend ourselves as best we can each fall, knowing that kind providence, will in our State, destroy the last vestige of our foe before the return of spring. Of course no winter or spring treatment is possible. The light traps used to destroy the moths do not by any means compensate for the cost. Thousands of them were used the past season at the cost of perhaps one dollar apiece and the results in protecting the cotton was practically nothing. It is an easily demonstrated fact that not 10 per cent. of the moths are allured even when placed as thickly as one to the acre. Let us not repeat the folly next year of using the lamps. The application of poison will save the crop. It may take more than one application, but its careful, persistent use will enable us to raise a good crop at any time in spite of the worms. Though this is a fact, let us not be short-sighted enough to consider the matter settled. The margin of profit on cotton is small enough as it is, without the additional expense of poisoning. Poisoning should be looked upon not as a solntion of the problem, but as a last resort.

The perfecting of methods for confining the worms to limited areas has as important bearing in the temporary region as in the permanent, as long as we are troubled by the worms, for it may result in a great saving in time and means in poisoning.

Much time, money and poison is now wasted by the crude methods that are now mainly employed. If by better apparatus 100 acres can be poisoned better by one or two men, and in the same time it ordinarily takes eight or ten men to do it, is it not

our own fault if we hardly make a living. Another thing is important. The poison must be applied at the right time. I have seen a man during a "scare" put on the poison so thickly as to seriously scorch the leaves when there was no need of the poison at all, except perhaps in a few small spots, and after the scare had passed over and the worms come in real earnest, this same man will set idly about and see his cotton eaten up without an attempt to save his crop.

I have in mind now, two fields, worked by different men, one poisened during a scare, before the worms appeared, and the other about two weeks later, when they really had come, and in two or three more weeks the first field had hardly a leaf left, and the other was as green and healthy as could be wished. These fields were side by side, with only a narrow field road between them. These cases are but examples of what occurred all over the region where the poison was used, and can you wonder why it is reports of the value of poisons are so variable.

I do not recommend the use of poisons in this State till the worms are distinctly ragging the cotton, and then it must be applied at once, and as often as that condition occurs. The idea being to use the least amount of poison that will give you a full crop.

WARNINGS.

Something that will probably be of great importance to this region, is the system of warnings, which it is the intention of the Station, to inaugurate the coming season. We intend to have correspondents in all parts of the permanent region, and between here and there, who will keep us constantly informed as to the condition of the worm. This will enable us to tell the farmers exactly where the worm is, and when we may expect it, and some idea of the probable severity of the attack. It has been well said, that to be forewarned is to be forearmed.

SUMMARY.

For about a century, the cotton worm has been destroying American cotton, appearing wherever cotton is grown, and migrating hundreds of miles from its feeding grounds. Its

egg is a beautifully ribbed flat disk of a deep bluish green color. The larva is variable in color, marked with longitudinal lines. It webs up in a leaf where it changes into a pupa, and shortly emerges as an olive brown moth, having an expanse of about an inch and a quarter. It takes about a month to go through its transformations, and it can pass the winter only under exceptionally favorable conditions, and in the moth state. There is a brood of worms in the spring on rattoon cotton before it attacks growing crops. It increases very fast, and acquires a migratory disposition and spreads far and wide. In the fall all die except in a portion of the South, which we call the permanent region, where a few are enabled to live over and perpetuate the species. The presence of moths in the winter and early spring, and the early brood on rattoon cotton is characteristic of the permanent region.

In the permanent region, the destruction of the moths in the winter or early spring, by traps should be attended to. The early spring brood should be starved out, or the moths allured by plants grown for that purpose, and then destroyed. Many would be destroyed if their natural enemies were protected, and especially early in the season, the worms should be destroyed in every way. Good results may be accomplished by inducing the moths to lay their eggs in limited areas, and the free use of insecticides, chief among which are kerosene emulsion and the arsenical compounds is recommended.

In the temporary, the use of Paris Green or London Purple, and they, only when really needed, is about the sum of the practical remedies. A system of warnings is projected.

APPENDIX I.

The Differences Between the Cotton Worm and the Boll Worm.—There are a number of insects which are mistaken for the cotton worm in one or another of its stages. Only one, the boll worm is, according to my experience, very often confounded with it by our farmers. These two insects are very different and may be readily distinguished as follows:

THE COTTON WORM.	THE BOLL WORM.
The eggs of both are ribbed and deposited on the under side of the cotton leaves, but	
that of one is flat, disk-like	while that of the other is higher than broad.
The larva of both feed on the leaves while young, but	
one continues to do so, while	the other soon begins to feed on the bolls.
One feeds only on cotton, while	the other attacks many crops.
The pupa of both is about the same size and general appearance, but	
one is formed on the leaves and	the other in the ground.
The moths of the two insects have a general resemblance, but	
one when at rest holds its wings, tightly closed on its back,	and the other holds them slightly elevated and partly open.

When carefully examined, many points of minute structure which will further enable one to distinguish them.

APPENDIX II.

How to Make the Moth Traps.—In making these traps, we must remember that the simplest is, as a rule, the best. I describe below what seems to me to be the simplest and best light and bait traps in use:

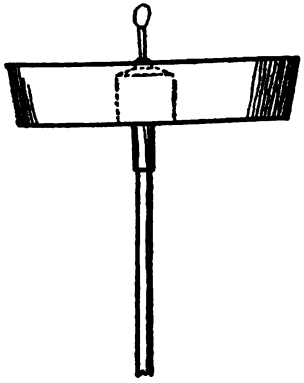


Figure 12.

The light trap is made by soldering to the center of the bottom of a one-half gallon pressed tin basin a tin tube two or three inches long, and about the diameter of a broom-stick. To the inside of the basin is soldered a a torch holding about a pint. A stick thrust into the ground, forms a support for the trap. For a wick, an unwound cotton rope answers very well and is cheap. About a half-inch of water is put into the basin and the surface covered with a film of kerosene.

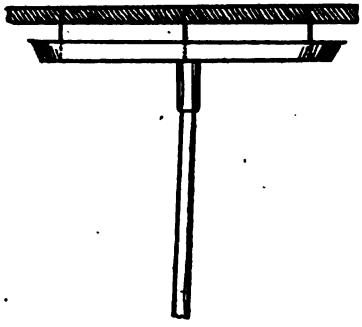


Figure 13.

The bait trap is even simpler and consists of a similar tube soldered to the bottom of a basin, which need not be half so large as for the light trap. To keep the rain out, a piece of board a little larger than the basin, should be provided. Drive three rather large nails into this and place on the basin. These nails should be long enough to leave at least three-quarters of an inch between the board and the edge of the basin. Use always the poisoned bait in the basin.

ARTICLE FIVE.—BOTANICAL NOTES.

The following pages have been prepared in answer to inquiries that have been received regarding diseases of plants and means of combating them.

Pear Blight:—Anything that kills pear and apple trees is commonly called blight, but every fruit grower knows and dreads the real pear blight, which is due to the bacterium named *Micrococcus amylovorus Burrill.* This parasite is a small oval body so small that if 25,000 of them were placed end to end they would make a line only about an inch long. It kills the parts invaded, causing the wood to become discolored, producing also a change in the appearance of the bark that is quite easily recognized by one who has seen it.

Surgery is about the only remedy. Every limb that shows the presence of the blight should be removed from the tree and burnt. Care should be taken that the knife that has been in the parts affected with the disease be not put into the healthy wood, as in this way the disease is often spread from tree to tree by pruning. A good plan is to have two sets of tools, with one of which the diseased parts are cut away, and with the other another piece of the stem is cut off to make certain. At the time of blossoming, the disease is spread greatly from tree to tree, often perhaps by insects. I have no doubt that the

tarnished plant bug is one of the greatest culprits in this line. No diseased wood should be allowed to remain on the trees, especially at this time of the year.

Sorghum Blight:—This disease is caused by a short, rod-like organism, *Bacillus sorghi Burril*, which I had the honor while working under Prof. Burrill, of discovering. It attacks all parts of the plant and undoubtedly causes a great shortage of the crop, if not killing the plant outright. It causes red spots or blotches on the sheathes near the ground, often making them entirely red. A similar appearance is found on the leaves and stem and the injury to the root is probably the greatest of all.

The disease germs may keep alive in the ground over winter so that neither of these crops should be grown on ground where plants having the disease were grown the preceding year. I detected the same disease the past season on Johnson grass, which also belongs to the Genus Sorghum, so that neither broom corn or sorghum should be grown on land where this grass occurs. The seed may be diseased, so that none grown on diseased plants should be used.

Grape Mildew.—There are two very different diseases, called mildew, one, the downy mildew of the grape *Pronosporo victocola DeBy*, grows on all the wild and cultivated grapes of this country. It attacks the leaves, young shoots and even the fruit, sending its mycelium all through the tissues of the plant, and when mature, the threads bearing the spores, project through the breathing pores of the leaf and produce the effect we call mildew or mold. The method of treatment must be entirely preventive, for after the fungus has entered the plant it is safe. Fungicides must be applied to the leaves, so as to prevent the germination of the spores.

The following mixtures have been successfully used:

Skawinski's Powders, 1.—Finely powdered copper sulphate, two parts; soot or alluvial earth, three parts; and coal dust, fifteen parts.

David's Powder.—Dissolve one pound of copper sulphate in the least quantity of hot water, and slack four pounds of lime

in the least amount of water required; when cold, mix thoroughly, and allow to dry in the sun When dry, crush and sift.

Sulphatine.—One pound of sulphate of copper; six pounds of sulphur and four pounds of air slacked lime, carefully powdered and mixed. Used for all three grape diseases.

Bordeaux mixture or Gironde mixture.—Dissolve one pound of sulphate of copper in four gallons of water, and in another vessel, one pound of lime in one and one-half gallons of water. When both are cool pour the copper solution slowly into the lime, constantly stirring.

Eau celest Blue water Audoynard process.—Dissolve one pound of copper sulphate in 3 or 4 gallons of warm water. When cool, add 1½ pints of ammonia and then dilute to 22 gallons. These per cents may be varied a great deal, and one must find by experiment what is the least amouut that may be used by him successfully.

The other form is the powdery mildew of the grape, *Uncinnula spiralis B. & C.* Its habit is very different from that of the downy mildew, as it lives all outside the plant. It can be more readily got at and nothing has been found to kill it better than sulphur. It is applied by dusting the powder on the leaves or on the ground beneath, or it is mixed with other fungicides. In all cases the effect of the sulphur is the result of the action of the heat of the sun, which evaporates it, producing on hot days quite a perceptible odor about the plants thus treated.

Sulphatine as described above, is useful, but a modification called the Esteve process may be better. One pound of sulphate of copper, 10 pounds of sulphur and 5 pounds of air slacked lime. Mixed as above and intended especially for potato blight.

The Black Rot.—This has been very destructive the past season. It attacks the leaf as well as the berry, but does but little injury to the former. This fact is very important, nevertheless as it occurs on the leaf at least a couple of weeks earlier than on the berries, so serving as a warning, which will allow

the grape grower to apply the remedies in time to save the fruit. In the leaf stage it shows itself as little reddish spots, which when examined closely, especially by means of a magnifier, will be found to possess numbers of minute black pustules, the *pycnidia*. The various mixtures described above, containing copper sulphate are quite successfully used against this disease.

APPENDIX III.

Below will be found an account of some experiments conducted at the station at Pine Bluff, and a letter from Mr. Sol Franklin giving his experience in fighting the worms, which we deem of sufficient importance to warrant publication.

POISONING THE COTTON CATERPILLAR.

An examination of the under surface of the cotton leaves in the last week in August, discovered many moth eggs, and a few very small worms. By September 6th a majority of the eggs had hatched, and an examination at this date discovered many worms and a very few eggs. By September 9th the young worms which had hitherto remained on the under surface of the leaf began to eat through the leaf and make their appearance on the upper surface. This was thought the proper time to poison and on the 10th a mixture of one pound of Paris Green to one of flour was dusted on. It was applied in the simplest possible way, a man on horseback riding between the rows and striking a stick, to each end of which was tied a sack of poison, on the pommel of the saddle.

The application of poison was almost completely successful. The day after poisoning a good many dead worms could be found on the ground. Three days after, live worms could be found only on occasional stalks that had not received their full share of poison.

The application of poison did not perceptibly affect the growth of the plant, the cotton continuing to grow and bloom and set its bolls until killed by frost.

EXPERIMENTS WITH POISON.

Object: To ascertain the best form in which to apply poi-

son. Six rows were used for each experiment. The poison for these experiments was applied on the 11th of September.

Plat 1. No poison.

Plat 2. Paris Green in water, one half pound to forty-eight gallons of water, sprayed on.

Plat 3. No poison.

Plat 4. Paris Green dusted on.

Plat 5. No poison.

Plat 6. One part of Paris Green to five parts of flour dusted on.

Plat 7. No poison.

Plat 8. One part of Paris Green to ten of flour dusted on.

The day after poison was applied enough rain fell for water to stand in the rows. A week after there was a very perceptible difference in the degree of protection afforded by the different forms in which poison was applied. The rows to which Paris Green mixed with flour was applied, received nearly complete protection, while those to which Paris Green alone and Paris Green in water received only partial protection, fully one half of the foliage being destroyed by the worms. The plats which were not poisoned were completely stripped.

These experiments go to show that Paris Green mixed with flour is more difficult to wash off than Paris Green alone, or mixed with water, and that for this reason, if for no other, poison should be mixed with flour or some other sticky substance, that will cause it to adhere to the leaves and resist washing.

GENERAL REMARKS.

If the poison is applied at the proper time, and there are no heavy rains immediately after poisoning, the ravages of the cotton worm can be prevented. That the cotton crop can be saved under these conditions has been established beyond all question. The proper time to apply poison, is when the worms of the third crop are beginning to eat through the leaf and make their appearance on its upper surface. To know exactly when this time comes will require continuous watchfulness on the part of the planter. After the moths have made their ap-

pearance in large numbers a close watch should be kept on the cotton field. During the first ten or twelve days of their existence the young worms remain on the under surface of the leaf, and during this time the leaves should be examined at least twice a week and every day if possible.

The planter who will watch his field closely, and poison when the young worms are beginning to make their appearance on the upper surface of the leaves, can hardly fail to succeed. The second crop is seldom sufficiently large to do serious injury save in particular fields or low spots. These particular fields or low spots should be closely watched, and poison applied if the worms appear in sufficient numbers to justify it.

We can not too strongly emphasize the necessity of continuous watchfulness from the time the worm first makes its appearance, until all danger is past, for upon this watchfulness and the ability to apply poison at a moment's notice will depend success in preventing the ravages of the worm.

A. F. CORY.

NOBLE LAKE, ARK., Jan. 17, 1890.

C. W. WOODWORTH,

Fayetteville, Ark.

DEAR SIR:—The cotton worms were first seen in this neighborhood about the 23d of July, 1889. The first crop was only in spots and very few. They webbed up but did no harm. Three weeks from that date, about the middle of August, the second crop was discovered in patches, (different parts of the place) in one to five acres in a place. As soon as they commenced to work I used three of Jas. P. Roaches' cotton worm destroyers, in which I used London Purple as a poison, in powder. This machine will powder from eight to ten rows at a time and from 70 to 80 acres per day. By using this machine it will take one and a quarter to one and a half pounds of poison per acre. I applied the poison on the second crop where the worms were first noticed, and thinking they would become general I powdered all of my cotton and used all the poison I had except about 400 pounds. After this, quite a number of the

second crop webbed up again, and fearing they would appear again, I purchased 1000 pounds of Paris Green. I experimented by mixing thoroughly, 400 pounds of London Purple with equal amount of Paris Green. Then the last or third crop made their appearance about the 2d of September. Then I applied with the machines, the mixture of London Purple and Paris Green with great success, effectually destroying the worms and saving the crop. In many places the worms had just commenced to eat the top crop. I then run the machine over them and killed them almost instantly. The cotton kept growing and fruiting to the very top of the stalk until frost, about the 8th of November, and after frost nearly all the matured bolls opened and made good cotton. My experience with the London Purple used by itself, is not as effectual as being mixed equally with Paris Green. Besides reducing the cost—as the London Purple is as cheap again as the Paris Green. Where the poisons were not used on the cotton, the worms fully destroyed all the top crop and a portion of the middle crop.

In regard to the *field lamps*, I would state that they proved to be a failure. We put them out about the 5th of July and kept them burning until the 20th of August. We caught a number of flies during the month of August, but to no purpose. It might have been that we commenced burning the lamps too late, as I learn the people in Texas commenced burning the lamps about the 1st of June. Besides, or even if the lamps could be used successfully, the whole neighborhood would have to use them, or unless they did it would be of no use.

Yours very truly,

SOL FRANKLIN.

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ACKNOWLEDGE THIS BULLETIN IF
SUBSEQUENT ONES.
The mailing list of the Station having
is desired to learn how many of the
sent. Please to have them continued
edge its receipt of this bulletin
wish to continue receiving
Arkansas Agricultural Experiment Stati
—AT—
Arkansas Industrial Univers

Third Annual Report

OF THE

Arkansas Agricultural Experiment Station

—AT—

Arkansas Industrial University

FAYETTEVILLE, ARK.

BRANCH STATIONS:

NEWPORT, PINE BLUFF

1890.

LITTLE ROCK, ARK.:
ARKANSAS DEMOCRAT CO., PRINTERS,
1891.

Third Annual Report

—— OF THE ——

Arkansas Agricultural Experiment Station

—— AT ——

Arkansas Industrial University,

FAYETTEVILLE, ARK.

ERRATA.

Page 138, line 3, read "corn and cob."
Page 146, line 4, read "any" in place of "no."

NEWPORT, PINE BLUFF.

1890.

ACKNOWLEDGE THIS BULLETIN IF YOU DESIRE ~~SUBSEQUENT ONES.~~

The mailing list of the Station having become very large, it is desired to learn how many of those to which Bulletins are sent do not ... Please, therefore, acknowledge the receipt of ... by giving full name and address, if you wish to continue your name on our list.

LITTLE ROCK, ARK.
ARKANSAS DEMOCRAT CO., PRINTERS,
1890.

HON. J. P. EAGLE, *Governor of the State of Arkansas.*

Sir:

I have the honor to herewith transmit the Third Annual Report of the Arkansas Agricultural Experiment Station.

I am, Sir,

Most respectfully, your obedient servant,

ALBERT E. MENKE,
Director.

ARKANSAS INDUSTRIAL UNIVERSITY.

AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

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G. A. HUMPHREYS.....Assistant Chemist.
F. CORY.....Assistant at Pine Bluff.
R. L. BENNETT.....Assistant at Newport.
W. F. BATES.....Assistant at Fayetteville.

FINANCIAL STATEMENT.

1890.

Labor	$ 744.76
Hardware	191.50
Stationery	118.50
Freight and Express	205.11
Stock	193.08
Sundries	183 01
Feed	237.29
Fertilizers	11.10
Library	75.58
Apparatus and Machinery	706.12
Salaries	7,850 52
Travel	600.46
Permanent Improvements	149.06
Printing	1,163.10
Seeds and Trees	223.36
Lumber and Wire	307.89
Newport Branch	663.11
Pine Bluff Branch	881.90
Helena and Little Rock	494.55
TOTAL	$15,000.00

The above statement is taken from the books of the Experiment Station.

ALBERT E. MENKE.

THE LOSS IN SILOS.

In order to determine the amount of loss that occurs in a silo, we filled our silos with corn and sorghum.

Corn put in		74,390 pounds.
Ensilage taken out	Good 46,138	
Ensilage taken out	Bad 17,893	
Total		64,031 pounds.
Per cent of good	38	

Sorghum put in		18,100 pounds.
Ensilage taken out	Good 10,189	
Ensilage taken out	Bad 2,865	
Total		13,054 pounds.
Per cent of good	43.7	

The sorghum was taken out daily during the month of December, the corn daily in January, February and March, the good and bad being carefully separated.

CORN AFTER RYE.

We sowed some land in rye at the rate of five pecks per acre with the object of determining the weight obtainable at different periods of maturity and further to see how it affected the yield of a corn crop immediately following it. We determined in different areas the amount of ear corn when allowed to mature and also the amount of green stalks and ears for silo use. The rye was sown on August 29th.

PLOT.	DATE CUT	CONDITION.	Pounds per acre.	Yield per acre of corn in bushels.	Yield per acre of silo corn.
1	May 12	In milk	2660	22.3	7600
2	May 8	In full bloom	2460	22.9	6400
3	" 5	All headed	2600	22.9	6800
4	" 1	Seven-eighths headed	2350	26.3	7700
5	April 28	Three-fourths headed	2040	24.3	8300
6	" 24	About half headed	1600	21.6	8300
7	" 21	Most advanced showing heads in boot	1700	28	8640
8	" 18	⅔ Jointing most advanced in boot	1600	32.8	8850
9	" 12	About ⅓ Jointing	680	28	7400
10	" 9	Most advanced Jointing	640	22.8	5800

CORN.

Our variety tests were continued in corn, the result of three years experiments, good years and bad, showed in every instance that White Giant Normandy (a late variety), was the best suited to N. W. Arkansas. We made some comparative tests with native varieties. A corn obtained from Mr. H. H. Harris, of Melbourne, Ark., gave a most excellent yield, coming within two bushels per acre of the White Giant Normandy. The past season was an extremely bad one in this section for corn and hence the generally low yield. The results of all varieties are appended in tabular form.

VARIETY.	Date of Tasseling.	Roasting ear.	Bu. Per Acre.	WHENCE OBTAINED.
Golden Beauty	June 22	July 20	20.6	J. M. Thorburn.
Blunt's Prolific	" 24	" 20	21.7	J. M. Thorburn.
Leaming, yellow	" 24	" 12	28.5	J. M. Thorburn.
Big Buck Eye	" 24	" 14	35.7	J. C. Vaughan.
Golden Dent	" 30	" 22	31.5	J. M. Thorburn.
King Phillip	" 6	" 4	Nothing.	J. M. Thorburn.
St. Charles White	" 30	" 20	34.1	Plant Seed Co., St. Louis.
Chester Co. Mammoth	" 28	" 20	30	J. M. Thorburn.
Rural Thoroughbred	" 24	" 14	17.5	J. C. Vaughan.
Long Yellow	" 20	" 14	16	J. M. Thorburn.
Golden Dewdrop	" 10	" 12	Nothing.	J. C. Vaughan.
Cranberry Dent	" 28	" 20	23.7	J. C. Vaughan.
Hickory King	" 24	" 24	24	J. M. Thorburn.
White Giant Normandy	" 30	" 24	49.7	Plant Seed Co.
Early Yellow Canada	" 12	" 4	24.3	J. C. Vaughan.
Woodworth's Yellow	" 16	" 10	23	J. M. Thorburn.
Mammoth White	" 28	" 28	40	J. M. Thorburn.
Queen of Prairie	" 20	" 12	20	J. M. Thorburn.
Mefold Fall	" 20	" 10	22	Plant Seed Co.
Thoroughbred White Flint	" 28	" 18	18	J. M. Thorburn.
Champion Early White Pearl	" 20	" 12	31.4	Plant Seed Co.
Mexican Creole	" 25	" 14	21.4	Louisiana Expert Station.
Welborn's Comtruitt	" 25	" 18	19.7	Louisiana Expert Station.
Ramp Prolific	" 5	" 28	21.4	Louisiana Expert Station.
Calhound Red Cob	" 5	" 25	20.9	Louisiana Expert Station.
Alabama Corn	" 5	" 25	17.1	Louisiana Expert Station.
White Mexican	" 10	" 30	20.9	Louisiana Expert Station.
McClenden Shoe Peg	" 5	" 25	9	Louisiana Expert Station.
Chamberlain's Prolific	" 5	" 28	8	Louisiana Expert Station.
Paterson's Acorn	" 10	" 30	7	Louisiana Expert Station.

ARKANSAS VARIETIES.

WHENCE OBTAINED.	TASSELED.	ROASTING EAR.	YIELD BUS. PER ACRE.
A. W. Blakemore, Medford	July 4	July 20	40
H. H. Harris, Melbourne	June 24	" 14	47.6
J. W. King, Gainesville	July 4	" 24	25.7
J. R. Ham, Hudge	" 4	" 20	44
C. C. Little, Kelt	" 4	" 20	29.7
F. H. Maloy, Dutch Mills	" 8	" 24	37.7
F. Henry, Magnet	" 8	" 28	28.6
Name not legible, Holly Springs	" 10	" 24	25.1
W. Beasly, Snider	" 10	" 28	23.3
R. A. Neal, ———	" 10	" 30	17.1
G. S. Nish, Yell Co	" 8	" 25	18.3

THE EFFECT OF COMMERCIAL FERTILIZERS ON CORN.

The variety used was White Giant Normandy. The yield was, in all cases, comparatively poor this year. The ground is indifferent in quality and very sandy. The corn was planted April 21st and re-planted May 13th.

PLOT.	FERTILIZERS USED. POUNDS PER ACRE.	TASSEL.	ROASTING EAR	Cost of Fertilizers.	Yield Bus. per Acre.	PROFIT Over Unfertilized.	LOSS.
1	250 C. S. M 200 A. P	July 4.	July 20.	$3.08	37	$7.42	.....
2	300 C. S. M 250 A. P	.....	.....	3.75	38	7.25	.....
3	200 C. S. M 200 A. P	.....	.....	2.40	32	5.60	.....
4	550 C. S. M.; 300 A. P	.....	.....	4.43	36.6	5.82	.....
5	400 C. S. M.; 350 A. P	.....	.....	5.10	33.7	3.65	.....
6	250 C.S.M.; 200 A.P.; 250 K	.....	.....	4.58	37.1	5.92	.....
7	300 C.S.M.; 250 A.P.; 250 K	.....	.....	5.25	39	6.25	.....
8	350 C.S.M.; 300 A.P.; 300 K	.....	.....	6.23	31.4	1.27	.....
9	400 C.S.M.; 350 A.P.; 350 K	.....	.....	7.20	27	.....	1.70
10	450 C.S.M.; 400 A.P.; 400 K	.....	.....	8.18	31.4	.....	.68
11	Nothing	.....	.....	.....	15.4	.....	.....
12	Nothing	.....	.....	.....	16.1	.....	.....

Corn valued at 50 cents per bushel.

The cost of Fertilizers used—

Cotton Seed Meal, (C. S. M.) ..... $15 per ton.
Acid Phosphate, (A. P.) ..... 12 per ton.
Kainit, (K.) ..... 12 per ton.

The above experiment, as in the past, shows the beneficial effects to be obtained from a dressing of cotton-seed meal and acid phosphate. The effects of each separately can be found in preceding reports.

POTATOES.

We made some fertilizer tests in potatoes, planting according to the *Rural New Yorker* method, previously described in last year's report. The past season was a poor one for early potatoes, and the yields obtained were generally low.

We planted on April 30th. The blossoms were noticed on June 14th, and the potatoes were dug August 7th and 8th. One year's tests are insufficient to warrant conclusions. The results were as follows:

FERTILIZERS—POUNDS PER ACRE.	Yield per Acre in bushels.	Per Cent Small.
300 Cotton Seed Meal	127.5	11
Nothing	117.5	9
400 Floats	114.1	8
Nothing	117.5	8
400 Dried Blood	119.1	8
300 Acid Phosphate; 300 Kainit; 300 Dried Blood	157.5	7.5
400 Wood Ashes	109.1	12
400 Cotton Seed Meal; 300 Kainit; 300 Acid Phosphate	140.8	12
300 Acid Phosphate	103.3	9
300 Acid Phosphate; 300 Kainit	112.5	13
500 Nitrate; 300 Acid Phosphate; 300 Kainit	94.1	15
300 Acid Phosphate; 300 Dried Blood	112.5	10
300 Kainit; 300 Dried Blood	95.1	11
300 Acid Phosphate; 300 Cotton Seed Meal	112.5	6
300 Kainit; 20,000 Barn Yard	90.8	15
20,000 Barn Yard	101.7	6.5
300 Acid Phosphate; 20,000 Barn Yard	114.5	13

GRASSES AT FAYETTEVILLE.

We made several tests of varieties of grasses at Fayetteville in order to determine if anything would have much success on a characteristic thin sandy soil.

VARIETY.	Sown per Acre Mar. 3,'90.	CONDITION OCT. 10, 1890.	CONDITION DEC. 8, 1890.
Seredella	40 lb.	Poor	Nothing.
Lupine	15 "	Nothing	"
Yellow Trefoil	15 "	Middling	"
Crested Dogstail	25 "	Nothing	"
Fall Fescue	40 "	Middling	"
Japan Clover	40 "	Poor	Good.
Wood Meadow	30 "	Poor	Half Stand.
Sheep Fescue	15 "	Nothing	Nothing.
Red Fescue	25 "	Poor	Almost Nothing.
Sweet Vernal	10 "	Poor	Nothing.
Meadow Foxtail	27.5"	Middling	Nothing.
Hard Fescue	30 "	Nothing	"
English Rye	80 qts.	Good	Half Stand.
Rough Stalk Meadow	20 "	Poor	Nothing.
Meadow Fescue	80 "	Good	Half Stand.
Italian Rye	25 "	Good	Half Stand.
Fall Meadow Oat	2 bus.	Good	Half Stand.
Dwarf Meadow	30 lb.	Poor	Nothing.
Fine Leafed Fescue	30 "	Poor	Nothing.
Yellow Oat	30 "	Middling	Nothing.
Water Meadow	30 "	Nothing	Nothing.
Rescue	30 "	Middling	Nothing.
Vetch	20 "	Middling	Half Stand.
Fiorin	32.5"	Middling	Half Stand.
Water Fescue	30 "	Nothing	Nothing.
Sainfoin	40 "	Poor	Nothing.

SUGAR BEETS.

We made some experiments on beets, with a view to determine the possibility of obtaining sugar therefrom. The results on both fertilized and unfertilized plots were unsatisfactory. Seed planted April 12.

VARIETY.	Yield per Acre
White, Green Top, B. B. Imperial	10,800
*Electoral	6,400
*Early Red Skinned	5,600
*Yellow Sugar Beet	8,000
*White, Grey Topped	7,200
*French, very rich	12,000
*Klein Wanozleben	9,600
*White, German	10,000
Sugar Beet for Pistillation	8,000
*Imperial	8,800
*White Imperial	8,000
*Black Skinned	6,000
*White, Red Top	11,600

The varieties asterisked were imported from Vilmorin, of Paris. The following fertilizer tests were made with American Imperial Sugar Beet, sown on April 12:

PLOT.	FERTILIZERS USED—POUNDS PER ACRE.	Yield. Pounds Per Acre.
1	50 Cotton-Seed Meal	7,342
2	100 Cotton-Seed Meal	7,514
3	150 Cotton-Seed Meal	10,971
4	Nothing	8,000
5	50 Acid Phosphate	13,280
6	100 Acid Phosphate	11,200
7	150 Acid Phosphate	8,000
8	Nothing	5,120
9	50 Kainit	6,560
10	100 Kainit	8,480
11	150 Kainit	7,040
12	Nothing	6,400
13	50 Cotton-Seed Meal 50 Acid Phosphate	5,760
14	100 Cotton-Seed Meal 100 Acid Phosphate	6,400
15	150 Cotton-Seed Meal 150 Acid Phosphate	6,040
16	150 Cotton-Seed Meal 150 Kainit	6,640

The sugar percentages appear in the Chemist's Report.

CHEMIST'S REPORT.

Director of the Arkansas Agricultural Experiment Station.

SIR:—Upon taking charge of the work here, the 20th day of September, 1890, there were turned over to me by Prof. C. B. Collingwood the results of the analysis of a large number of grasses and such of the work on sorghum as had been done up to that date, which was about one-third of the entire work done on sorghum during the season. A brief report of the work of the department up to the present time will be found on the following pages under their appropriate headings.

Respectfully,

G. L. TELLER.

ANALYSES OF GRASSES.

This work was undertaken and performed by Prof. Collingwood and Mr. G. A. Humphreys. It consists of the analysis of about thirty specimens of Arkansas grasses, of different varieties and at different stages of growth. Believing that the purpose of the Station can be best served by publishing the results in connection with other work, they will be reserved for a future bulletin, in which they will be printed in full with due credit to the parties who did the work.

SORGHUM ANALYSES.

The work on sorghum comprises the complete analyses of three hundred and fifty-two samples of juice and a partial analysis of two hundred and twenty-five others. It was begun and about one-third completed under the directions of Prof. Collingwood. It may be divided under three heads: 1st. To study the effect of fertilizers upon the yield of cane sugar. 2d. A comparison of varieties. 3d. An examination of the juice as an index to the selection of seed.

1. *The effect of fertilizers upon per cent of sucrose or cane sugar.*—To study this point, forty plots, comprising one-fiftieth of an acre each, were planted with seed of Early Orange Sorghum. Three of the plots were left without fertilizers. The remainder of the plots were treated with different amounts of one or all of the following:

Kainit, acid phosphate and cotton seed meal. These were scattered broadcast over the plots immediately after planting the seed.

The work of analysis, beginning September 3d, was carried on after the canes were ripe. Two of the most fully developed canes from each plot were taken for each analysis. From ten to twenty analyses from different plots were made each day, and an effort made to go over the series of plots each time as quickly as possible. Seven complete series of analyses were made. The average of the results is shown in table.

1. The canes were cut close to the ground, weighed, stripped and topped and again weighed. The two stripped stalks were then passed between the rollers of a crusher, the juice collected in weighed glass jars and its weight in ounces determined. After allowing the coarse particles of broken stalk to settle, the specific gravity of the liquid was determined by weighing a definite volume. The total solids were determined by use of a Brix spindle, which is an ordinary hydrometer, so graduated that the reading indicates directly the per cent of solids; that is, the residue that would be left by carefully driving off all the water. Nineteen degrees Brix means, then, that if we were to evaporate one hundred ounces of the juice to dryness there would be about nineteen ounces of solid matter remaining.

The *sucrose*, or cane sugar, was determined by a delicate polariscope and the *glucose*, or grape sugar, was determined by the method described by Dr. Collier in his work on sorghum.*

The glucose ratio was determined by dividing the per cent of sucrose and multiplying the result by 100.

The coefficient of purity shows the relation of the sucrose to the whole amount of solids present. It was found by dividing the per cent of sucrose by the degrees Brix and multiplying the result by 100.

A high per cent of sucrose, together with a high purity co-efficient and a low glucose ratio, indicate a superior juice.

Experience in plot experiments everywhere indicates that there is a great difficulty in securing several plots which are uniform throughout and which would, without any fertilizers, yield like results, and the many other sources of error which necessarily occur in such work, even when it is carried on with the greatest possible care, makes it necessary to accept apparent conclusions with much caution and reserve. Notwithstanding these facts, there are some indications

*See also Report of U. S. Department of Agriculture for 1879, p. 66.

in the results which are worthy of note. A few small variations cannot carry much weight, and even large variations in very exceptional instances may be overlooked.

Table II. is designed to show the relation which the various plots hold to each other when the per cent of sucrose in juice is considered. The table is so arranged that the figures in the first column represent the per cent of sucrose in the juice from the plots treated as indicated at the side on the corresponding lines. The figures in the remaining three columns indicate the per cent of sugar in the juices from those plots which were treated with 5 lb., 10 lb. or 15 lb. of kainit, as indicated at the top of the column, in addition to what was used for the corresponding lines in the first column.

A comparison of the figures in column one with those of the remaining three, will show that in every instance but two there is an increase in the per cent of sucrose in the juice over the corresponding plots which were not treated with kainit.

At the back of the brackets will be found the per cents included within, up to the straight line in front of each. While the average of the plots which were treated with cotton seed meal or with acid phosphate alone is practically the same as that of the three plots which had no fertilizer, the average of the plots which had kainit alone is three-fourths of a per cent higher. The average of the plots treated with kainit and acid phosphate is one-half a per cent higher than the average of those treated with acid phosphate alone. The average of those treated with cotton seed meal and kainit is one-third of a per cent higher than the average of those treated with cotton seed meal alone; and the average of those plots treated with acid phosphate, kainit and cotton seed meal is one-half of one per cent higher than the average of those treated only with acid phosphate and cotton seed meal together.

A similar relation exists in regard to kainit and acid phosphate in the experiments carried on here last year, the results of which are published in the Second Annual Report. The relation holds there both in the Early Amber and the Early Orange varieties. Cotton seed meal was not then used to any extent in connection with kainit.

A comparison of the per cents of sucrose in the stripped canes. shows practically the same relations to exist.

The indications are strongly in favor of the conclusion: *That application of kainit had a beneficial influence upon the amount of sugar in the canes and juice.*

Unfortunately we have no means of estimating the yield of sugar per acre, but a comparison of the average weights of the canes selected, shows those which produced the lowest per cents of sucrose to be no larger than those which showed the higher per cents.

It is noticeable further, that while either cotton seed meal or acid phosphate alone did not seem to alter the per cent of sucrose, yet when taken together they seem to have increased it.

The largest per cents of sucrose were present when cotton seed meal, acid phosphate and kainit were used together.

The per cent of sucrose is less when cotton seed meal or acid phosphate alone were used in connection with kainit than when kainit was used alone. With regard to the acid phosphate and kainit, the same was true in the experiments of last year.

I take the liberty of quoting in this connection a summary of results obtained on five years' experiments in New Jersey, as given on page 6 of Bulletin No. 54 of the New Jersey Agricultural Experimental Station:

"YIELD OF SUGARS."

"1. Without exception muriate of potash has noticeably increased the total yield of sugar per acre.

"2. Without exception this increase has exceeded that caused by a combination of nitrogen and phosphoric acid.

"3. Without exception this increase has exceeded that caused by combinations of nitrogen, phosphoric acid and potash.

"4, With a single exception this increase has exceeded that caused by a combination of phosphoric acid and potash.

"5. The total yield of sugar per acre, grown with the aid of muriate of potash, has been exceeded in two cases out of three by a combination of nitrogen and potash; it has also been exceeded in all cases by the yield from plots fertilized with barnyard manure; in no case, however, has this excess been greater than six per cent.

"The results secured from similar experiments on sorghum at Rio Grande, Cape May county, during 1885, 1886 and 1887, corroborate the above statements in nearly every particular, and admit of the conclusion *that potash is the element which exerts the most marked effect upon the yield of sorghum and upon the production of sugar.*"

Cotton seed meal is comparatively rich in nitrogen, acid phosphate in phosphoric acid, and kainit in potash.

The results of the foregoing experiments at this Station agree with those above quoted except where all three of the compounds were united.

2. *Comparison of Different Varieties of Sorghum.*—Eighteen plots were planted with different varieties of seed sent from Washington. The means of the results of four analyses, made as described under the foregoing topic, are given in Table IV. The degrees Brix of the juice in the cane from which the seed was selected is given in the first column. It is noticeable that in nearly every case the degree Brix of the juices analysed here is lower than in that of the cane from which the seed was selected. All of the varieties polarized, on an average, more than fourteen per cent sugar. Of the six varieties the juices of which showed more than fifteen per cent of sugar, all but one (Link's Hybrid) were said to be crosses. The same varieties show a relatively high purity co-efficient.

3. *Analyses of Juices as an Index to the Selection of Seed.*—For this purpose partial analyses were made of the juices from two hundred and twenty-seven single canes. The object in view is to select seeds for planting from those canes which are richest in sugar. By so doing, it is hoped to secure in time canes of a better quality than those we have at present. In this way sugar beets of a superior quality have been produced in Germany from seed which were grown from beets much poorer in sugar.

SUGAR BEETS.

During the summer of 1890 there were grown upon the college farm thirty plots of beets of one-fiftieth acre each. The soil is a somewhat heavy clay loam with clay subsoil. The plots grew fourteen different varieties of beets, as shown in Table V. The White Imperial sugar beet was grown on several plots, with and without fertilizers.

In October the beets were dug, topped and weighed, and samples selected for analysis. Most of them were small and the plots yielded very lightly.

In analyzing, six beets from each plot were used. The portions below the leaf scars were grated, wholly or in equal parts, upon an ordinary root grater. The juice was pressed from a weighed amount of the pulp by means of a small laboratory screw press, and after weighing was analyzed in the same way as the sorghum juice. It is somewhat remarkable that in only one case was the per cent of sucrose in the juice above nine per cent, whereas the same varieties of beets in other localities frequently yielded a juice showing from fourteen to eighteen per cent.

The White Imperial beet yielded a juice which contained 11.8 per cent of sugar, but even this amount is too small to make the production of sugar profitable. The question of sugar beets in Arkansas will be further studied the coming season.

SWEET POTATOES.

Nine different varieties of sweet potatoes grown at Newport in 1890 were analyzed as were also the vines of two of them. The results of these analyses are published in connection with the report of Mr. Bennett, of the Newport Branch, at whose request they were made.

Method of Analysis.—Upon receipt of the potatoes they were cut into thin slices and carefully air dried, reserving samples for determination of the total moisture. Portions of them were grated as in case of the beets and the juice polarized for the amount of sucrose. The juice was small in amounts, heavily charged with starch and polarized from three and three-fourths to seven and three-fourths per cent of sugar.

When the potatoes were air dry they were pulverized for analysis. The portion for determination of the starch and sugars was made fine enough to pass through a silk cloth sieve of about one hundred and thirty meshes per inch.

The glucose was determined by digesting four grams of the finely powdered substance for sixteen hours in 200 c.c. of distilled water of ordinary temperature, with occasional shaking. It was then filtered and the amount of reducing sugar determined by the method of Allihn, essentially as described in the report of the New Haven Connecticut Station for 1887, page 129. The amount of copper oxide reduced by 50 c.c. of the solution of sugar was collected on asbestos in a glass tube, reduced to metallic copper in dry hydrogen and the amount of glucose corresponding to the pure copper determined by means of Allihn's Table. The method proved reasonably rapid and satisfactory.

To 50 other c.c. of the solution, obtained as above, 100 c.c. of 3% HCl were added in a 200 c.c. flask, digested at 65 degrees C. for thirty minutes, cooled made up to 200 c.c., filtered and the glucose in 50 c.c. determined as above. The increase in glucose estimated on one gram of potato was multiplied by .95 and the result considered as sucrose.

To two grams of fresh substance in a 200 c.c. flask were added 150 c.c. of 2% HCl and the whole digested at the temperature of boiling water for three hours. It was then cooled, made up to the mark and filtered through a dry filter. As the amount of solid residue was very small no allowance was made for it. The glucose in 10 c.c. of the solution obtained was determined as before, using 40 c.c. of water to make the volume equal. From the amount of glucose here obtained and estimated upon one gram of potato the glucose obtained from sucrose and that originally present were deducted; the remainder was multiplied by .9 and the result considered as the amount of starch.

While owing to the presence of unknown substances these results cannot be considered as entirely correct, yet they may serve as a basis of comparison.

The other constituents were determined by the methods adopted by the Association of Official Agricultural Chemists.

OTHER CHEMICAL WORK.

During the winter the milk of two cows spayed a year before was analyzed night and morning for a week. It is expected to again analyze the milk of these cows in May and the results will be published at a future date.

Analyses were made of the nine samples of feed used in the feeding experiment at Newport. The melting points were also determined of the tallows of the eleven animals fed in the experiment. It is expected that the results will be published elsewhere.

METEOROLOGICAL OBSERVATIONS.

Believing that a continuous record of the weather is of importance in connection with much of the work of the station and a matter of interest generally, a set of instruments has been secured, a suitable shelter erected and observations are now taken three times daily upon the precipitation, humidity, temperature, wind, clouds, etc. Monthly returns are made to the Chief of the State Weather Service at Little Rock and a copy of the record kept on file for future reference and perhaps publication.

From the first of last December till after the first of March much of the office and general work of the station devolved upon me and has to a considerable extent retarded the work of the department.

Respectfully submitted,

GEO. L. TELLER.

TABLE 1.

Averages of Results of Seven Analyses of Early Orange Sorghum from Plots Treated with Different Fertilizers.

Number of Plot.	KIND OF FERTILIZER.	Weight of Unstripped Canes in Ounces.	Weight of Stripped Canes in Ounces.	Per Cent of Juice Expressed.	Per Cent of Sucrose in Juice.	Per Cent of Glucose in Juice.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.	Per Cent of Sucrose from Stripped Canes.
1	5 lb Cotton-Seed Meal	65.4	45.7	42.9	14.72	.53	1.073	19.8	80.0	3.6	6.31
2	10 " " "	58.6	41.7	41.9	14.43	.59	1.071	18.3	78.8	4.1	6.05
3	15 " " "	61.2	43.4	44.2	13.95	.66	1.068	17.6	79.3	4.7	6.16
4	10 " " " 5 " Acid Phosphate,	62.1	45.1	43.0	14.77	.43	1.071	18.3	80.7	2.9	6.35
5	15 " Cotton-Seed Meal 5 " Acid Phosphate,	62.5	45.3	44.7	14.74	.43	1.072	18.0	81.9	2.9	6.55
6	5 " Cotton-Seed Meal 5 " Acid Phosphate,	74.2	53.2	40.8	15.12	.38	1.073	18.4	82.2	2.5	6.17
7	10 " Cotton-Seed Meal 10 " Acid Phosphate,	64.2	47.9	41.3	14.88	.42	1.070	18.1	82.2	2.8	6.15
8	15 " Cotton-Seed Meal 15 " Acid Phosphate	67.5	50.1	41.7	15.50	.34	1.075	18.9	83.9	2.2	6.31
9	5 " Cotton-Seed Meal 5 " Acid Phosphate, 5 " Kainit	72.0	55.2	43.4	15.28	.35	1.075	18.3	83.5	2.9	6.63
10	10 " Cotton-Seed Meal 10 " Acid Phosphate 5 " Kainit	70.8	50.5	43.4	15.18	.36	1.071	18.0	84.5	2.4	6.59
11	Nothing	75.7	55.9	42.4	14.79	.48	1.071	18.1	81.7	3.2	6.27
12	15 " Cotton-Seed Meal 15 " Acid Phosphate 15 " Kainit	76.7	59 3	42.3	15.27	.40	1.072	18.2	83.9	2.6	6.46
13	10 " Cotton-Seed Meal 10 " Acid Phosphate 5 " Kainit	78.5	56.0	43.1	15.91	.43	1.076	18.9	84.1	2.7	6.85
14	10 " Cotton Seed Meal 5 " Acid Phosphate 5 " Kainit	74.0	57.0	42.2	15.81	.45	1.075	18.4	85.9	2.8	6.67
15	10 " Cotton-Seed Meal 5 " Acid Phosphate 10 " Kainit	74 0	55 5	41.2	16.05	.41	1.075	18.8	85.3	2.5	6.61

TABLE 1—CONTINUED.

Averages of Results of Seven Analyses of Early Orange Sorghum from Plots Treated with Different Fertilizers.

Number of Plot.	KIND OF FERTILIZER.	Weight of Unstripped Canes in Ounces.	Weight of Stripped Canes in Ounces.	Per Cent of Juice Expressed.	Per Cent of Sucrose in Juice.	Per Cent of Glucose in Juice.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.	Per Cent of Sucrose from Stripped Canes.
16	15 lb Cotton-Seed Meal 15 " Acid Phosphate 5 " Kainit	70.4	52.9	41.8	16.03	.46	1.077	19.3	83.0	2.9	6.70
17	15 " Cotton-Seed Meal 5 " Acid Phosphate 15 " Kainit	78.1	59.4	44.2	15 62	.44	1.074	18.8	82.9	2.8	6.90
18	15 " Cotton-Seed Meal 5 " Acid Phosphate 5 " Kainit	75.2	56.5	42.2	15.19	.58	1.071	18.2	83.4	3.8	6.41
19	5 " Cotton-Seed Meal 10 " Acid Phosphate 10 " Kainit	85.6	62.5	44.7	15.37	.48	1.072	18.4	83.5	3.2	6.87
20	5 " Cotton-Seed Meal 15 " Acid Phosphate 15 " Kainit	76.4	57.7	42.9	14.95	.42	1.072	18.4	81.3	2.8	6.41
21	Nothing.	70.2	53.2	44.4	14.15	.42	1.068	17.5	80.1	3.0	6.27
22	10 " Cotton-Seed Meal 5 " Kainit	74.9	58.2	42.8	15.20	.51	1.072	18.1	84.0	3.4	6.49
23	15 " Cotton-Seed Meal 5 " Kainit	71.1	53.8	43.4	14.28	.71	1.068	17.5	81.6	4.9	6.20
24	5 " Cotton-Seed Meal 5 " Kainit	71.0	52.9	42.3	14.76	.66	1.070	17.5	84.3	4.5	6.24
25	10 " Cotton-Seed Meal 10 " Kainit	69.4	50.2	45.7	14.40	.78	1.069	17.9	80.4	5.4	6.58
26	15 " Cotton-Seed Meal 15 " Kainit	70.0	50.5	43.6	15.18	.59	1.072	18.2	83.4	3.9	6.62
27	5 " Acid Phosphate	66.0	49.0	41.6	14.88	.60	1.072	18.1	82.2	4.0	6.19
28	10 " Acid Phosphate	68.9	50.7	44.8	14.37	.65	1.069	17.4	82.6	4.5	6.44
29	5 " Kainit 10 " Acid Phosphate	76.7	56.7	41.2	14.50	.63	1.069	17.5	82.9	4.3	5.97
30	15 " Acid Phosphate	74.8	54.6	43.3	14.31	.52	1.069	17.6	81.3	3.6	6.19
31	Nothing.	81.4	58.7	44.4	14.49	.50	1.069	17.5	82.8	3.4	6.43

TABLE 1—CONTINUED.

Averages of Results of Seven Analyses of Early Orange Sorghum from Plots Treated with Different Fertilizers.

Number of Plot.	KIND OF FERTILIZERS.	Weight of Unstripped Canes in Ounces.	Weight of Stripped Canes in Ounces.	Per Cent of Juice Expressed.	Per Cent of Sucrose in Juice.	Per Cent of Glucose in Juice.	Specific Gravity of Juice.	Degrees Brix.	Purity Coefficient.	Glucose Ratio.	Per Cent of Sucrose from Stripped Canes.
32	15 lb Acid Phosphate 5 " Kainit	79.4	58.5	46.2	14.59	.51	1.069	17.5	85.3	3.5	6.59
33	5 " Acid Phosphate 5 " Kainit	74.6	56.5	44.3	15.19	.58	1.073	18.1	85.9	3.8	6.73
34	10 " Acid Phosphate 10 " Kainit	67.0	51.4	42.2	14.88	.72	1.070	17.8	85.6	4.8	6.28
35	15 " Acid Phosphate 15 " Kainit	69.3	52.5	42.9	15.18	.53	1.072	18.1	83.8	3.5	6.51
36	5 " Kainit	78.0	57.3	44.1	15.60	.50	1.073	18.3	85.2	3.2	6.88
37	10 " Kainit	77.2	56.4	43.6	14.95	.43	1.071	18.1	82.6	2.9	6.52
38	15 " Kainit	81.0	60.0	42.4	15.11	.59	1.072	18.3	82.6	3.8	6.42
39	5 " Acid Phosphate 10 " Kainit	74.2	54.6	42.1	15.09	.37	1.072	18.4	82.0	2.4	6.35
40	5 " Acid Phosphate 15 " Kainit	73.2	54.5	41.6	15.44	.44	1.073	18.6	83.0	2.8	6.42

TABLE 2.

Per Cents of Sucrose in Juices from Sorghum Grown on Plots Differently Fertilized. (See Text.)

FERTILIZERS USED.		NOTHING.	5 lb KAINIT.	10 lb KAINIT.	15 lb KAINIT.
Nothing		14.15	15.60	14.95	15.11
"	14.47	14.49			
"		14.79		15.22	
5 lb Acid Phosphate		14.88	15.19	15.09	15.44
10 " " "	14.52	14.37	14.50	14.88	.....
15 " " "		14.31	14.59	.....	15.18
				14.98	
5 lb Cotton-S'd M'l		14.72	14.76	14.40	.....
10 " " " "	14.37	14.43	15.20	.....	15.18
15 " " " "		13.95	14.28	.....	.....
				14.76	
5 lb Acid Phosphate 5 " Cotton-S'd M'l		15.12	15.28	.....	.....
5 " Acid Phosphate 10 " Cotton-S'd M'l		14.77	15.81	16.05	.....
5 " Acid Phosphate 15 " Cotton-S'd M'l	15.00	14.74	15.19	.....	15.62
10 " Acid Phosphate 10 " Cotton-S'd M'l		14.88	15.18	15.91	.....
15 " Acid Phosphate 15 " Cotton-S'd M'l		15.50	16.03	.....	15.27
10 " Acid Phosphate 5 " Cotton-Seed Meal			.....	15.37	.....
15 " Acid Phosphate 15 " Cotton-Seed Meal			.....	.....	14.95
				15.51	

TABLE 3.

Average of Four Analyses of Each of Eighteen Varieties of Sorghum, 1890.

NAME OF VARIETY.	Degree Brix of Juice in Cane from which Seed was Taken.	Weight of Unstripped Stalks.	Weight of Stripped and Topped Stalks.	Per Cent of Juice	Per Cent of Sucrose.	Per Cent of Glucose.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.	Per Cent Sucrose in Stripped Canes.
Jyangetonsbi	19.	90.4	55.	40.4	14.08	.45	1.069	17.0	82.81	3.20	5.69
Cross of Unknown Varieties	21.	76.1	53.	37.8	15.09	.81	1.073	18.3	82.43	5.37	5.70
Planters' Friend	19.	81.6	57.7	41.1	14.59	.67	1.076	18.8	77.61	4.59	6.20
Cross of Amber and Orange	22.5	81.	54.3	43.3	15.36	.80	1.075	18.2	84.37	5 86	6.65
Rio Blanco		93.	61.1	40.7	14 29	1.16	1.071	17.7	80.72	8.12	5.82
Neayna	19.	80.7	53.8	53.8	14 58	1.37	1.071	17.8	81.93	9.40	6.15
Red Siberian	19.	91.3	64.	42.8	14.03	1.23	1.071	17.5	80.17	8.77	6.00
Cross of Link's Hybrid and Orange	18.	76.5	54.3	39.8	15.99	.71	1.075	18.0	88.84	4.44	6.36
Undenbule	21.	96 7	77.6	44.5	14.24	.56	1.070	17.5	81.37	3.93	6.36
Unknown Cross of India	16.	80.8	57.2	39.9	15.22	.23	1.072	17.8	83.37	1.51	6.73
Cross of Amber and Link's Hybrid	19.	88.7	59.	43.6	14.29	1.16	1.067	17.5	81.66	8.12	6.23
Kansas Orange	20.	92.3	58.2	44.6	14.42	.73	1.068	17.3	83.37	5.06	6.43
Link's Hybrid		62.5	40.2	41.6	15.03	.50	1.075	19.1	78.68	3.40	6.25
Sorghum Bicolor	20.	103	78.	40.6	14 89	1.39	1.070	18.1	82 28	8.66	6.19
Ubehlaria	18.	76.5	53.2	43.8	14.48	1.50	1.072	18 2	79.56	10.60	6.34
Cross of India and Orange	22.	81.3	50.1	47.8	15.28	1.18	1.073	18.7	83.03	7.79	7.32
Variation of Honduras	20.	71.3	49.1	44.8	14.67	.90	1.072	18 0	81 51	6.13	6 57
Red Siberian	20.5	84.1	55.	42.9	14.07	1 78	1.069	17.6	77 29	12.86	6.04

TABLE 4.

Results of Fertilizer Analyses, 1891.

No. of Sample.	Name of Brand.	Name of Manufacturer or Dealer.	Place of Manufacture.
1	Stern's Ammoniated Raw-Bone Superphosphate	Standard Guano and Chemical Manufacturing Co....	New Orleans, La.
2	Champion Farmer's Choice	Standard Guano and Chemical Manufacturing Co....	New Orleans, La.
3	Acid Phosphate	Standard Guano and Chemical Manufacturing Co....	New Orleans, La.
4	Kainite	Standard Guano and Chemical Manufacturing Co....	New Orleans, La.
5	Cotton and Corn Fertilizer.	Planters' Fertilizer Manufacturing Co.....	New Orleans, La.
6	Cotton and Corn Fertilizer.	Robert Brown Oil Co.....	St. Louis, Mo.

No. of Sample.	Nitrogen.		Phosphoric Acid, P^2O^5.				Potash soluble in water, as K^2O.
			Available P^2O^5.				
	Actual.	Equal to Ammonia.	Soluble.	Reverted.	Insoluble.	Total.	
1	2.10	2.55	8.11	2.44	.96	11.51	2.57
2	1.47	1.78	5.15	3.30	2.32	11.77	1.16
3	.....	.....	12.02	1.88	1.25	15.20	.....
4	.....	.....	.....	.....	.....	.....	12.42
5	2.50	3.03	7.03	2.29	.35	9.67	.71
6	3.19	3.87	6.88	1.69	1.66	10.23	3.10

TABLE 5.

Analyses of Sugar Beets Grown On University Farm, 1890.

VARIETY.	KIND OF FERTILIZERS.	Weight in Pounds of Beets from Each Plot.	Weight in Ounces of Six Beets.	Weight in Ounces of Six Beets Below Leaf Scars.	Per Cent of Juice Expressed.	Per Cent Sucrose in Juice.	Per Cent Glucose in Juice.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.
Electoral		32	96	71	51.9	7.86	.06	1.042	10.6	74.1	.76
White Grey Top		36	82	66	63.1	7.45	.21	1.039	10.0	74.5	2.82
White Red Top		58	154	104	62.5	8.00	.04	1.041	10.5	76.2	.50
White German		50	104	72	54.7	8.17	.09	1.040	10.2	80.1	1.10
White Imperial		40	81	47	62.5	11.80	.12	1.053	13.5	87.4	1.02
French		60	129	80	50.0	8.17	.23	1.042	11.0	74.3	2.81
Klein Wanozbelen		48	97	67	48.4	8.64	.23	1.042	10.5	82.3	2.66
Sugar Beet		40	95	54	56.6	8 95	.43	1.042	11.0	81.3	4.80
Early Red Skin		28	70	55	56.3	7.23	.98	1.034	10.2	70.8	13 55

TABLE 5—CONTINUED.

Analyses of Sugar Beets Grown on University Farm, 1890,

VARIETY.	KIND OF FERTILIZER.	Weight in lb of Beets from Each Plot.	Weight in Ounces of Six Beets.	Weight in Ounces of Six Beets Below Leaf Scars.	Per Cent of Juice Expressed.	Per Cent Sucrose in Juice.	Per Cent Glucose in Juice.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.
White Green Top		54	113	90	57.8	7.86	2.52	1.037	10.8	72.8	25.87
Black Skinned		30	80	66	50.0	8.17	.22	1.038	11.0	75.3	2.69
Imperial		44	135	104	53.1	7.70	.43	1.037	10.4	74.0	5 85
Yellow Sugar Beet		40	72	56	53.1	8.80	.28	1.039	11.0	79 8	3.18
Imperial Sugar Beet	*2½ Cotton-Seed Meal	66	139½	108	59.3	6.91	1.24	1.034	9.8	70.5	17.65
" " "	5 " "	64	123	83	57.8	7.23	.41	1.034	10.0	72.3	5.15
" " "	7½ " "	96	98	78	59.3	7.38	.36	1.036	10.4	70.9	4.89
" " "	Nothing	70	114	90.5	57.8	7.23	.73	1.035	10.0	72.3	10.09
" " "	2½ Acid Phosphate	166	90	80	57.8	8.48	.43	1.035	11.0	77.2	5.07
" " "	5 " "	140	171	132	60.9	8.48	.34	1.035	11.0	77.1	4.01
" " "	7½ " "	100	147	120	54.7	7.23	.58	1.033	10.4	69.5	8.02
" " "	Nothing	64	115	87	56.3	7.54	.55	1.033	10.3	73 21	7.29

TABLE 5—CONTINUED.

Analyses of Sugar Beets Grown on University Farm, 1890.

VARIETY.	KIND OF FERTILIZER.	Weight in lb of Beets from Each Plot.	Weight in Ounces of Six Beets.	Weight in Ounces of Six Beets Below Leaf Scars.	Per Cent of Juice Expressed.	Per Cent Sucrose in Juice.	Per Cent Glucose in Juice.	Specific Gravity of Juice.	Degree Brix.	Purity Coefficient.	Glucose Ratio.
Imperial Sugar Beet	2½ Kainit	82	103	73	53.7	8.71	.98	1.036	11.0	79.2	4.13
" " "	5 "	106	143	101	56.2	8.04	.62	1.038	10 4	77.3	7.71
" " "	7½ "	88	105½	75	51.5	6.91	.65	1.035	9.8	70.5	9.41
" " "	Nothing	180	129	104	59.3	7.54	.20	1.036	10.8	69.8	2.65
" " "	2½ Cotton-Seed Meal 2½ Acid Phosphate	72	177	144	51.8	8.70	.12	1 040	11.0	79.0	1 38
" " "	5 Cotton-Seed Meal 5 Acid Phosphate	80	180	145	62.5	7.86	.12	1.038	10.6	74.1	1.53
" "	7½ Cotton-Seed Meal 7½ Acid Phosphate	78	235	170	54.7	8.18	.16	1.040	11.0	74.4	1.95
" " "	7½ Cotton-Seed Meal 7½ Kainit	83	204	142	64.2	7.38	.10	1.036	10.0	73.8	1.35

* Figures indicate pounds per plot of $\frac{1}{60}$ acre, each.

HORTICULTURE.

JEROME McNEILL.

The past year has been an unfavorable one for the interests of horticulture at the experiment station. The writer who filled temporarily the place of horticulturist arrived on the ground April the eleventh. This was already a late date for planting many varieties of vegetables, and all planting was delayed further by the extremely wet weather of the spring and early summer. This rainy season stopped suddenly and almost immediately a severe drouth ensued, so that these causes operated together to make many experiments so inconclusive that they will not be published. If it is true that good weather is of more importance to a crop than manure it is evident that the effect of fertilizers in experiments may be entirely counteracted by unfavorable weather, so that it is extremely unsafe to draw any conclusions on the effect of fertilizers under such circumstances. For this reason we are compelled to say that most of the fertilizer tests with vegetables have been inconclusive.

TOMATOES.

An attempt was made to ascertain what fertilizer would give the best results on the worn soils of the hills in Northwest Arkansas. For this purpose five rows of the Paragon tomato were set out on the 31st of May. These rows were each one hundred and eighty-seven feet long. The first row was fertilized with Sodium Nitrate at the rate of 800 pounds to the acre. The Nitrate was mixed with three times its volume of well rotted chip dirt and this as well as the other fertilizers was thoroughly incorporated with the earth of the hills on which the plants were

set. The second row was fertilized with Acid Phosphate and Cotton Seed Meal at the rate of 750 pounds of the first and 2250 pounds of the second per acre. The third row was fertilized with Kainit at the rate of 1000 pounds per acre. The Kainit being well mixed with well rotted chip dirt as in the case of the Nitrate. The fourth row was fertilized with Cotton Seed Meal at the rate of 3000 pounds to the acre, and the fifth row was left unfertilized except for a light coating of stable manure which had been spread over the whole plat and plowed in the fall before. How far the presence of this manure went to spoil the experiment is uncertain. The experimentor was ignorant of its presence until it was too late to obtain another piece of ground. The plants were supported by a barrel hoop tacked to three upright stakes at a height of about three feet from the ground. The nails were not driven into the stakes their whole length but only far enough to hold well. They were thus easily drawn out of the wood with a claw hammer, and at the end of the season stakes and hoops were both collected and placed under shelter. This method of supporting the plants has proven efficient and economical. The fruit rotted badly but at the end of one month during which time the rotten tomatoes were measured separately from the good fruit there was no appreciable difference in the proportion of the rotten to good fruit in each row. Apparently the presence or character of the fertilizer had no decided effect upon the prevalence of rot.

The first row fertilized with 800 pounds Nitrate per acre yielded 528 bushels per acre.

The second row fertilized with 750 pounds Acid Phosphate and 2250 pounds Cotton Seed Meal per acre yielded 483 bushels per acre.

The third row fertilized with 1000 pounds of Kainit per acre yielded 486 bushels per acre.

The fourth row fertilized with 3000 pounds of Cotton Seed Meal per acre yielded 379 bushels per acre.

The fifth row unfertilized (except as noted above) yielded 433 bushels per acre.

At fifty cents per bushel the value of the yield of the fertilized over the unfertilized rows, the cost of the fertilized required to make the increase and the profit or loss occasioned by its use are given in the table below.

ROW.	Increase in Bushels	VALUE OF INCREASE (50 cents per Bushel.)	COST OF FERTILIZER.	PROFIT OR LOSS.
1	95	$47.50	$24	Profit, $23.50.
2	50	25.00	22.17	" 2.83.
3	53	26.50	6	" 20.50.

VALUE OF FERTILIZERS PER TON.

Cotton Seed Meal	$13.00.	Sodium Nitrate	$60.00.
Kainit	12.00.	Acid Phosphate	20.00.

Since the yield of the fourth row did not yield as much as the one unfertilized, the value of the fertilizer used (19.50), would at least be lost. It would seem from this experiment that nitrogen was needed since it so largely increased the yield in the first experiment, but the nitrogen of cotton seed meal is apparently not available for this plant. After nitrogen, in sodium nitrate, potash seems to be most efficient in increasing the yield, and the acid phosphate used in the second experiment (giving it the credit of the whole increase since the cotton seed meal when used alone was of no benefit), while less effective than the other two increased the yield enough to be profitable. If the cost of the cotton seed meal is deducted from the cost of the fertilizer used in the second experiment, the three fertilizers when their cost is compared with the yield produced would rank kainit, acid phosphate, nitrate of sodium.

CUCUMBERS.

An effort was made to ascertain the truth as to the value of planting cucumbers around a pit filled with manure which is kept wet. Holes were dug triangular in shape with the sides three feet long and a depth of eighteen inches. These holes were filled with stable manure which contained a considerable amount of straw. A hill of cucumbers was planted on each of the sides of the triangular. At a distance of eight feet three hills of the same variety were planted in the same relative positions as in the first case but without the pit or the manure. This experiment was repeated with thirteen varieties. The plants came up well and a good stand was secured in every case except one. For two or three weeks after they were planted the weather was very dry and during this time the manure in the pits was thoroughly soaked with water. The cucumbers were gathered when large enough for table use at intervals of about five days and counted. The accompanying table gives a summary of the results.

VARIETIES.	YIELD OF THREE HILLS.	
	GROWN ABOUT A PIT.	GROWN IN ORDINARY HILLS.
1	9 Cucumbers	0 Cucumbers.
2	31 "	9 "
3	0 "	0 "
4	59 "	46 "
5	37 "	33 "
6	30 "	36 "
7	12 "	7 "
8	48 "	6 "
9	78 "	89 "
10	35 "	48 "
11	38 "	43 "
12	82 "	106 "
13	4 gal. 3 pt. (Gherkins), 459 for thirty-three hills.	3 gal. 3 pts., 423 for thirty-three hills.

If we are justified in drawing any conclusion from a single experiment we can only say that this plan is of very doubtful advantage, five out of twelve varieties having actually done better with only ordinary cultivation and without any fertilizer and there is so little difference in the totals that it is evident that the slightly increased yield would not pay for the greatly increased cost.

APPLES.

In the first annual report a list of the varieties of apples growing on the station farm was given. The varieties given numbered eighty—they have since increased to one hundred and ten besides sixteen varieties of crabs. A list of the apples and crabs now growing here is subjoined. A considerable part of the orchard has about reached the bearing age, and no doubt a considerable crop would have been gathered if the blossoms had not been killed by the severe cold of last spring. In a few cases the trees themselves were injured. Two out of six Shannons were killed outright, the same proportion of Buckinghams' and one Shockley out of six.

Alexander,
Antonooka,
Aport Seedlings (252),
" " (261),
" " (316),
Arkansas Beauty,
" Black,
" Red,
Babbitt,
Bogdonoff,
Batullen,
Belle Flower,
Ben Davis,
Bennoni,
Blackwood,
Longfield,
Loy,
Maiden's Blush,
Mammoth Black Twig,
" Pippin,
Mann,
Milam,
Missouri Pippin,
Moore's Ruby,
Northwestern Greening,
Occident,
Paragon,
Pennsylvania Cider,
Poorhouse,
Porter,

Boiken,
Borovinka,
Borsdoffer,
Bright Water,
Buckingham,
Crawford,
Cross,
Cardinal Cellini,
Climan Pippin,
Clayton,
Coffelt Beauty,
Duchess,
Early Cotton,
" Harvest,
" May,
" Pennock,
" Ripe,
Everblooming,
Fameuse or Snow,
Gano,
Gano's Red,
Gill's Beauty,
Good Peasant,
Gravenstein,
Great Mogul,
Grimes' Golden.
Grindstone,
Hars,
Hatcher's Seedling,
Himbeer,
Hacket's Swect,
Horse,
Jenitou,
Jonathan,
Kosenhager,
Kossuth,
Langford's Seedling,
Plum Cider,
Red Aport,
" Astrachan,
" Bietigheimer,
" Stettin,
" Winter Pearmain,
Roman Stem,
Rome Beauty,
Rutherford,
Rambo,
Salome,
Sandyglass,
Shackelford,
Shannon,
Shirley's Keeper,
Shockley,
Smith Cider,
Sops of Wine,
Stark,
Strawberry Chenango,
Stevenson Pippin,
Stewart,
Stuart's Golden,
Stump,
Sweet Bough,
Switzer,
Tetofskey,
Thaler,
Voronist,
White Winter,
Willow,
Wine Sap,
Winter May,
With Our Compliments,
Wolf River,
Woolsey's Seedling,
Yellow Forest,

Lawyer,	" Transparent,
Lead,	" Reinette,
Limber Twig,	York Imperial.

CRABS.

Florence,	Quaker Beauty,
Gibb,	Richland Winter Sweet,
Hyslop,	Sweet Russet,
Kentucky Red (Cider),	Sylvan Sweet,
Looker's Winter,	Transcendent,
Martha,	Telfer's Sweet,
Minnesota,	Van Wycks Sweet,
North Star,	Winter Golden Sweet.

COLD STORAGE FOR APPLES.

An attempt was made to ascertain whether cold storage could be profitably employed for keeping apples, with ice so expensive as it is here. The fruit house employed in the experiment is a frame structure, built entirely above ground with double walls of tongue and grooved yellow pine. These walls are separated by a six inch air space and each wall is lined on the inside with heavy building paper. The dimensions of the house are 15 by 17 feet outside with a height of 16 feet to the eaves. The inclosed space is divided into two chambers by a row of 2 by 6 joists placed one foot apart at a height of ten feet from the floor which is made of cement. The lower chamber is supplied with two windows one on the west side and one on the east 6 feet by 18 inches furnished with double sash and a solid wooden shutter and a door 2 feet 8 inches by 6 feet 8 inches on the north side which has double doors. The floor of the upper chamber consists of galvanized iron sheets soldered into one piece which extends over the joists described above and up on to the sides of the room. This metal floor slopes gradually to a point two feet from the middle of the south wall. At this point the exit pipe for water from the melting ice is placed. This pipe leads directly out through

the south wall of the building. It is evident that it would be a much more economical plan to have the outlet pipe run around the inside of the wall of the lower chamber several times before making its exit as the water from melting ice is as cold as ice itself at the melting point and by conducting this water through the storage chamber until its temperature had increased eight degrees, a lower temperature could have been secured than was found possible with the present arrangement and the lower temperature in the storage chamber would have caused the ice in the chambers above to melt more slowly. The ice chamber is supplied with one door 2 feet 4 inches by 6 feet placed in the north side and furnished with a single door. The roof is furnished with a ventilator similar to those used on the roofs of barns. About the middle of October ten tons of ice bought at Fort Smith, Ark., was put in the ice chamber. This ice was placed directly upon the galvanized iron floor but it was kept at least twelve inches from the wall on all sides. When in position it was covered to a depth of eighteen inches with saw-dust as dry as could be obtained. The storage chamber will hold at least seven hundred bushels of apples packed in barrels, but it was thought unnecessary to fill the house to demonstrate the success of the plan, so ninety-four bushels of apples packed in barrels were obtained and placed in the storage room as soon as the ice was in place. These apples with the exception of a few bushels were scarcely as good as the average of this year's crop. Thirty-six bushels were selected from a lot that had been piled on the ground in the orchard where they were grown and allowed to remain there until a considerable proportion of the whole lot were rotten. These apples kept badly, had they been as good as the remainder the showing would have been decidedly more favorable. The temperature of the storage chamber was found to be 42° F., on the morning after the apples were stored and the variation during the fall and winter was not more than ten degrees. The lowest observed being 40° and the highest 50°. The apples were picked over once after they were put in the house and again when they were sold. In estimating the

expense of the experiment the cost of the labor item can only be approximated as the work was done by students almost entirely and it is quite difficult to determine accurately the value of such labor. It is thought however that any inaccuracy in this item will not be sufficient to vitiate the conclusions reached as the result of this experiment. If the house had been filled there would have been no additional expense for ice or saw-dust, but only for the first cost of the apples and the extra cost of handling which may be considered to be exactly proportionate to the cost of the apples necessary to complete the number required to fill the house. In estimating the profit or loss resulting from the experiment, then, it will be assumed that seven hundred bushels of apples were bought instead of one hundred and a proportionate number sold.

COST.

387	bushels	Limber Twigs	at 50	cents	$193	50
67	"	Wine Sap	" 80	"	53	60
67	"	Milam	" 80	"	53	60
179	"	Ben Davis	" —	"	143	20
10 tons of ice at $8 per ton at Fayetteville					80	00
8 loads of saw-dust at $1.25 per load					10	00
Expense of two teams for one half day for transferring ice from depot to storage house					2	50
Expense for six hands for one half day to assist in loading and storing ice					3	00
Expense for fourteen hands for one day to assist in picking over and packing apples					14	00
144 barrels at 20 cents each					28	80
					$582	20

The Limber Twigs brought on the average $1.52 net in Fort Smith, while in the same market Wine Sap sold for $1.77 net and Ben Davis for $1.95 net. The Milams were almost a total loss as there were too few sound ones left when the others were marketed to be worth offering for sale.

AMOUNTS REALIZED FROM SALE OF APPLES.

279	bushels	Limber Twigs	at	$1.25	net	$424 08
72¾	"	Ben Davis	"	1.25	"	141 86
52	"	Wine Sap	"	1.77	"	92 04
		Total amount realized from sales				$657 98
		Total expense				582 20

Excess of amount received from sales over expense $ 75 78

Even if this apparent profit should not be diminished by the legitimate charges of interest, insurance and repairs it would scarcely be large enough to be considered a satisfactory return for the outlay. The result would have been much more satisfactory, however, if all of the apples had been Limber Twigs. In this case the excess of receipts over expenditures would have been $184.40, but if the variety had been Wine Sap the excess of receipts over expenditures would have been $379.10 which would certainly be a satisfactory profit. All things considered the result of the experiment is encouraging, but the experiment should be repeated before any general conclusions are drawn.

COATING APPLES WITH PARAFINE.

An experiment was tried with apples to ascertain whether a thin coating of parafine would afford any protection against the rot. The apples experimented upon were dipped in hot parafine and quickly removed, care being taken however that the apples were completely covered even to the stem. Bruised and partially rotted as well as smooth specimens were experimented upon. The result is not encouraging. Imperfect specimens rot very soon. Sound apples do not seem to keep better when treated in the manner described than when left in the natural state.

STRAWBERRIES.

The past season has been a bad one for strawberries at this Station. The destructive frosts in March in many cases seriously injured the plants and destroyed the flower beds of the earliest varieties. The continuous cold rainy weather, which prevailed during April and the first half of May, delayed the ripening of the early berries. The heavy rains prevented insects from carrying on their business of pollenization, so that the fruit did not set properly. Finally, the drouth of June and July did considerable injury to the already weakened plants. As a result not more than half a crop was gathered and the fruit was below the average in quality, though perhaps not in size.

The accompanying table should need no explanation. It may be well to state, however, that the estimated yield per acre, given in the fifth column, is based upon living plants. That is to say, if half of the plants are dead in a row one hundred feet long, the length of the row is considered to be fifty feet. This method was adopted because it was thought that it would be of more value to compare the yield on equal areas of living plants than to make the comparison between plants all living and plants ten, or fifty, or ninety per cent dead. A few points in the table are worthy of special attention. Of the old varieties planted in the spring of 1888, Bubach No. 5 and Crescent are easily first in amount of yield. No other berry in this list can be properly said to be second to them but Kentucky; Chas. Downing, Daniel Boone, May King, Mrs. Garfield, Primo and Sharpless come next upon the list. As far as this series of experiments is concerned, Mammoth Seedling, Warner, Jewell, Iron Clad, Early Canada and Paerry may be considered to be complete failures. In the list of varieties planted in the spring of 1889, Warfield No. 2 is conspicuous for its heavy yield, while Daisy and Louise stand very well for the second place. While no others on the list are quite so prolific as the three just named, there are a half dozen or more

that are quite promising and certainly worthy of trials. Nothing is said in the table concerning the size and quality of the berries planted in 1888, as this information has already been given in the First and Second Reports of this station. If nothing is said of the size or quality of some of the new berries (those planted in 1886), it may be assumed that nothing remarkable was observed in them as they grew here. The Haverland is certainly one of the most remarkable of the new berries. It is conical in shape, about one inch in diameter at the base, and from one and a half to two inches long. The fruit lies directly upon the ground, which it almost covers. It is a little inclined to become soft at the tip before the base is well ripened. It will certainly prove a very desirable berry, except for long distance shipping.

In the last six columns the per cent of berries ripening during stated intervals is shown. According to this showing, ten varieties have twelve or a large per cent of their berries to ripen before May 12th, viz:

Jersey Queen,	Finch Seedling,	Iron Clad,
Early Canada,	Hart's Minnesota,	Champion,
Miner,	Henderson,	Primo.
Logan.		

Eleven varieties have twelve per cent or more of their berries to ripen from June 10th to 18th, inclusive, viz:

Kentucky,	Glendale,	Capt. Jack.
Mrs. Garfield,	Prince of Berries,	Cumberland,
Gandy's Pride,	Haverland,	Carmichael,
Oregon Everbearing,		Eureka.

If Carmichael be not counted (it produced scarcely enough berries to furnish a basis for an estimate of its yield), Glendale leads the list with twenty-eight per cent, although the total amount of fruit produced is probably not greater than that produced by Eureka.

The following varieties have eighteen to twenty-five per cent of their fruit to ripen before May 20th: Jersey Queen, Bidwell, Manchester, May King, Gypsy, Monmouth and Lady Rusk.

And these varieties ripen from twenty-five to thirty-five per cent of their berries before the same date: Finch Seedling, Wilson, Crystal City, Windsor Chief, Hoffman, Ontario and Daisy.

The following varieties ripen from thirty-five to forty-five per cent of their fruit before this date: Jessie, Belmont, Cloud, Parker, Earle.

Finally, Iron Clad, Early Canada, Hart's Minnesota, Champion, Miner, Henderson, Logan, and (Early) No. 1, ripen more than forty-five per cent of their fruit by May 20.

Of the last class the two first mentioned have proven the least desirable. All of the varieties named in the accompanying table are being reset at the present time, so that they will all have another trial under new and changed conditions. In conclusion, I present the names of a few of the leading varieties for earliness, freedom from disease, etc.:

Three *earliest* varieties, *productiveness* not being taken into account: *Crystal City*, *Early Canada*, *Sharpless*.

Three varieties producing the *most fruit* during the *first week* of the season, *i. e.*, May 5 to 11 inclusive: *Champion*, *Miner*, *Logan*.

Three *best early* varieties that show *least injury by leaf blight*: *Miner*, *Henderson*, *Logan*.

Three *best early* varieties, considering *productiveness*, *thriftiness* and *freedom from leaf blight*: *Logan*, *Sharpless*, *Miner*.

Three *medium early* varieties which are *most thrifty*: *Early No. 1*, *Monmouth*, *Daisy*.

Three *medium early*, *least injured by leaf blight*: *Ontario*, *Early No. 1*, *Daisy*.

Three *medium early* varieties, *most productive*: *Daisy*, *Cloud*, *Crescent*.

Three *best medium early* varieties, considering *productiveness*, *thriftiness* and *freedom from injury by leaf blight*: *Daisy*, *Cloud*, *Crescent*.

Three *medium late* varieties, *most productive*: *Warfield No. 2*, *Bubach No. 5*, *Louise*.

Three *medium late* varieties, most free from *injury by leaf blight: Bubach No. 5, Gold, Warfield No. 2.*

Three *medium late* varieties, *most thrifty: Bubach No. 5, Warfield No. 2, Legal Tender.*

Three *best medium late* varieties, considering *productiveness, thriftiness* and *freedom* from *leaf blight: Warfield No. 2, Bubach No. 5, Louise.*

Two *late* varieties, *injured least by leaf blight: Haverland, Eureka.*

Three *most productive late* varieties: *Glendale, Eureka, Haverland.*

Three *late* varieties, most notable for *thriftiness: Gandy's Prize, Haveland, Eureka.*

Three *best late* varieties, considering *productiveness, thriftiness* and *freedom* from *leaf blight: Eureka, Haveland, Glendale.*

Three varieties which *remain longest in bearing*, and which *produce most berries* at the *beginning* and *end* of the season: *Jersey Queen, Capt. Jack, Eureka.*

My choice for a home garden: *Sharpless, Haverland, Bubach No. 5, Crescent, Warfield No. 2.*

TABULATED FIELD NOTES ON STRAWBERRIES.

	VARIETIES.	Planted.	Appearance and Stand, May 17, Scale of 10.	Injury from Leaf Blight, June 21, on Scale of 10.	Thriftiness, June 21, on Scale of 10.	Rate of Yield, per Acre, Qts.	First Picking.	Last Picking.	Per cent of Berries Ripening May 5 to 11.	Per cent of Berries Ripening May 12 to 19.	Per cent of Berries Ripening May 20 to 26.	Per cent of Berries Ripening May 27 to June 2.	Per cent of Berries Ripening June 3 to 9.	Per cent of Berries Ripening June 10 to 18.	
1.	Jersey Queen	Spring, 1888	5	1½	5½	1635	May 7	June 11	8	10½	49	24	6½	2	
2.	Kentucky	"	9	2½	6½	4525	" 7	" 14	2	9	35½	18½	24½	10½	
3.	Bubach No. 5	"	10	½	9½	9880	" 9	" 14	½	1½	29	44	24	½	
4.	Mam. Seedling	"	4	4	4½	980	" 13	" 9	0	16	25	37	22	0	
5.	Bidwell	"	9	1½	8½	3290	" 7	" 14	2	19	26	33	16	4	
6.	Jas. Vick	"	7	1½	6	2500	" 12	" 11	0	12	30½	39	12½	6	
7.	Finch Seedling	"	6	2	7½	1940	" 9	" 9	10	25	45	15	5	0	
8.	Jumbo	"	6	2½	7	2159	" 10	" 11	1	9	37	25	24	4	
9.	Monarch	"	.....	3	4½	2890	" 10	" 9	0	5	42	35	18	0	
10.	Wilson	"	9	2	7	2850	" 7	" 11	5½	33	13	43	5½	0	
11.	President Lincoln	"	9	2	7½	3850	" 16	" 9	0	4½	49	32½	14	0	
12.	Warner	"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Plants all dead.
13.	Jessie	"	6	1½	8	1790	May 5	June 18	6	41	41	6	4	2	
14.	Crescent	"	9	4	7½	8750	" 7	" 18	½	5	45	26	18	6	
15.	Captain Jack	"	.....	1	5	2020	" 7	" 11	3	6	35	26	18	12	
16.	Aunt Smith	"	4	2	6½	3500	" 19	" 11	0	3	55	33	5	4	
17.	Jewell	"	2	.....	.....	.....	" 7	" 4	.....	.....	.....	.....	.....	.....	{ Almost killed out.
18.	Chas. Downing	"	3	2½	7	4330	" 7	" 9	0	½	45	40	14	0	{ Excellent in quality.
19.	Iron Clad	"	4	1	6	645	" 9	May 19	27	73	0	0	0	0	
20.	Atlantic	"	9	5	4½	2905	" 12	June 14	0	5	36	49	4	6	
21.	Prince of Berries	"	4	1	4	1840	" 12	" 4	0	16	17	42	12½	12½	
22.	Crystal City	"	9	2	10	1660	" 5	" 9	4	24	41	14	17	0	
23.	Crimson Cluster	"	9	2	6	3445	" 9	" 11	1	13	42	38	4	2	
24.	Daniel Boone	"	5	2½	5½	4705	" 12	" 4	0	5	20	40	35	0	
25.	Early Canada	"	4	1½	5	615	" 7	May 27	42	24	35	0	0	0	
26.	Big Bob	"	7	4	4	2860	" 21	June 14	0	0	63½	20	10	6	
27.	Manchester	"	7	3	5	2190	" 10	" 9	1½	21	48	20	9½	0	
38.	Piper	"	9	1	8	1875	" 13	" 4	0	6	16	72	6	0	
29.	Glendale	"	6	2½	5½	2975	" 27	" 14	0	0	0	50	32	28	
30.	Mt. Vernon	"	8	1½	6	2850	" 9	" 14	3	0	34	49	8	6	
31.	May King	"	9	3	7	4220	" 7	" 4	2	16	50	25	7	0	
32.	Belmont	"	5	2	8	1750	" 9	May 26	4	36	60	0	0	0	
33.	Legal Tender	"	10	1	9	2865	" 13	June 11	0	9	70	7	7	7	
34.	Parry	"	2	.....	.....	.....	" 13	" 2	0	5	20	75	0	0	
25.	Captain Jack	"	6	1	5	2635	" 9	" 11	3½	9	46	20½	17	4	
36.	Hart's Minn	"	6	1	9	1965	" 9	" 11	17	50	33	0	0	0	

TABULATED FIELD NOTES ON STRAWBERRIES—CONTINUED.

VARIETIES.	Planted.	Appearance and Stand, May 17, Scale of 10.	Injury from Leaf Blight, June 21, on Scale of 10.	Thriftiness June 21, on Scale of 10.	Rate of Yield per Acre, Qts.	First Picking.	Last Picking.	Per cent of Berries Ripening May 5 to 11.	Per cent of Berries Ripening May 12 to 19.	Per cent of Berries Ripening May 20 to 26.	Per cent of Berries Ripening May 27 to June 2.	Per cent of Berries Ripening June 3 to 9.	Per cent of Berries Ripening June 10 to 18.	REMARKS.
37. Champion	Spring 1888	3	2½	5	2730	May 9	June 11	20	33½	32	7½	7	0	
38. Windsor Chief	"	7	1½	6½	1935	" 12	" 4	0	28½	32	34	5½	0	
39. Mrs. Garfield	"	3	1½	5	4350	" 16	" 11	0	1	34	29	19	17	
40. Miner	"	4	1	6	2755	" 12	" 11	20	50	20	10	0	0	
41. Henderson	"	2	1	5	1635	" 9	May 21	22	56	22	0	0	0	
42. Primo	"	.....	3	5	4130	" 12	June 11	0	11	46	34	4½	4½	
43. Sharpless	"	9	3	7	4560	" 5	" 14	2½	22	39	23	12½	1	
44. Jumbo, (Cumberland)	"	4	3½	8	2310	" 17	" 11	0	3	23	28	12	9	Badly killed out; very fine.
45. Fragaria Virginiana	.....	10	3	9	.....	.....	.....	0	0	0	0	0	0	This is the common wild strawberry.
46. Ohio	Spring 1889	10	5	6	580	May 26	June 14	0	0	0	41	53	6	Of little account. [No fruit.
47. Logan	"	6	2	5½	4230	" 9	" 9	12	36	24	15	13	0	Medium to large.
48. Louise	"	10	2	8½	6910	" 12	" 18	0	6	40	43	4	7	Medium to large size.
49. Hoffman	"	10	2	8½	456	" 9	" 9	3	28	34	25	10	0	Good in quality.
50. Gypsy	"	10	2	9	4505	" 9	" 9	1½	23½	33	53	9	0	Med. sized berry, inclined to be soft.
51. Bubach No. 132	"	10	½	9	980	" 27	" 3	0	0	0	50	50	0	Large firm berry.
52. Pearl	"	10	6	4	5355	" 9	" 9	3	11½	39	27	19½	0	A failure.
53. Ontario	"	10	½	7½	4440	" 9	" 8	4	22	32½	31½	10	0	Medium to large, fair quality.
54. Monmouth	"	10	1½	8	4860	" 9	" 9	4½	19	17	48½	11	0	Very large berries.
55. Clara	"	6	4	5	2710	" 13	" 9	0	0	53½	28½	18	0	Medium in size.
56. Daisy	"	10	1	8	7880	" 9	" 9	4	22½	47	13½	13	0	Large.
57. Clingto	"	10	2½	7½	5205	" 12	" 9	0	½	42	40	17	0	Medium to large size, of good quality.
58. Gandy's Pride	"	10	1	9	2665	" 22	" 18	0	0	17½	51	21½	10	Medium in size.
59. Miami	"	6	2	5½	920	" 9	" 9	5	11	36	39	9	0	Very large; of good quality.
60. Carmichael	"	10	.....	.....	.....	June 9	" 9	0	0	0	0	50	50	Medium or small in size; a failure here.
61. Eureka	"	10	½	8	5145	May 9	" 18	1½	6	36	24½	13	18½	
62. Haverland	"	9	½	9½	5028	" 19	" 11	0	1½	40	36	12	10	Large; a very promising late variety.
63. Gold	"	6	½	9	3160	" 22	" 11	0	0	21	47	28	4	Very large and fine, (see description.)
64. Warfield No. 4	"	10	1	8	10945	" 19	" 14	0	2½	31	37	28	2	[productive.
65. Cloud	"	10	2	9½	5675	" 9	" 14	7	26	39	17	10	1	Medium in size; fine quality; very
66. Burt	"	8	3	5	1840	" 12	" 9	0	12	0	48	40	0	Medium in size and quality.
67. Parker Earle	"	9	1½	9	1225	" 12	May 27	0	41½	31	27½	0	0	
68. (Early) No. 1	.....	10	0	10	2490	" 10	" 29	½	45	45	9½	0	0	
69. (Late) No. 2	.....	.....	2	7½	4305	" 9	June 11	2	5½	26	48	13	5½	Large.
70. Lady Rusk	Spring 1889	.....	1½	7	3875	" 16	" 2	0	18	80	0	0	0	Large and fine; a little soft.
71. Oregon Everbearing	.....	.....	3	9	5795	" 9	" 11	½	8	23	51	7	10	One of the best.

The following varieties have been planted during the present season. They have suffered from the dry weather:

	VARIETIES.	PLANTED.	Injury from Leaf Blight, June 21.	Proportion of Plants Showing Injury by Leaf Blight.
72	Michel's Early	March, 1890	1	$\frac{9}{24}$
73	Sugar Loaf	"	1	$\frac{9}{24}$
74	Charlestown	"	2	$\frac{19}{21}$
75	Truitt	"	2	$\frac{18}{22}$
76	Patuxent	"	1	$\frac{7}{23}$
77	Farnsworth	"	1	$\frac{13}{22}$
78	Stayman's No. 2	"	1	$\frac{8}{23}$
79	Crawford	"	1	$\frac{10}{26}$
80	Golden Defiance	"	2	$\frac{19}{25}$
81	Southard's No. 1	"	1	$\frac{12}{24}$
82	Southard's No. 2	"	1½	$\frac{17}{24}$
83	Montreuil	"	1	$\frac{14}{24}$
84	Coville	"	1	$\frac{9}{22}$
85	Belle Bordelaise	"	1	$\frac{6}{26}$
86	Stayman's No. 2	"	1	$\frac{8}{24}$
87	Excelsior	"	1	$\frac{18}{19}$
88	Warren	"	0	0
89	Lemming's White	"	1½	$\frac{21}{21}$
90	Van Deman	"	1	$\frac{4}{12}$
91	Bedar Wood Seedling	April, 1890	1	$\frac{8}{15}$
92	Barnes' Large White	"	1	$\frac{1}{3}$
93	Unknown	"	1½	$\frac{4}{8}$
94	Bouquet	August, 1890	.....	.....

PLUMS AND APRICOTS.

With few exceptions the plums and apricots growing on the Station, a list of which will be found in the First Annual Report are in good health, and most of them should have borne a fair crop of fruit last year, but the severe cold of March, after the warm February, seems to have killed all of the fruit buds of every variety but one. This single exception, the ———, bore a good crop of fruit, and it certainly deserves to be considered a sure bearer.

Of the Japan plums, two have proven not sufficiently hardy for this climate. Three out of six Prunus Limoni were killed, and both of the Satsuma trees growing here were killed back to within two feet of the ground. These stems, however, have sent out thrifty branches which grew from three to six feet last season. One of the two Alberge apricots growing here was also killed by the cold.

GRAPES.

The grapes planted in the spring of '88, bore for the first time the past season, and the accompanying table gives in a condensed form the most important items in our experience. A glance at the last column of the table will show that the yield was, with comparatively few exceptions, very poor. The principal causes of this poor yield are, first, the evident unfitness of many of the varieties for this locality; second, the prevalence of rot; third, the depredations of the grape leaf-folder, and fourth, the unfavorable situation of the vineyard. This is situated on a moderately steep hillside with a south-eastern exposure. After rains the ground is springy and the soil is naturally poor and so rocky as to be difficult of cultivation. In spite of these naturally unfavorable conditions, many varieties have made from ten to twenty feet of growth in the past season, and have produced fair to excellent crops of fruit,

showing clearly that soil and climate are naturally well adapted to the grape. The grape leaf-folder has been extremely troublesome, and it was found necessary to remove the infected leaves twice during the season, by hand picking. This is so expensive a cure that it doubtfully pays in any sense. The mere cost of the labor was about ten dollars per acre for each picking, and to this item of expense must be added the injury done to the vines in removing a large proportion of their leaves. And still another evil effect of this practice must be noted in the delayed and imperfect ripening of the fruit. This last consideration will probably explain the great length of time between the first and last pickings as shown by many varieties in the sixth column of the table. Less injury was done to the wood than was expected, as at the time of spring pruning it was found to be well ripened with only a small proportion of new wood dead. No doubt the pretty severe cutting back of the new wood at the time when the leaves were picked, did much to secure this result, and the long fall and mild winter was at least equally beneficial to the health of the vines. Notwithstanding the apparently little injury suffered by the vines at this I still think it a practice of doubtful economy to remove a large proportion of the leaves from immature wood, and the problem of finding a less costly and more effective way of dealing with the grape leaf-folder remains to be solved, and upon its successful solution largely depends, in my opinion, the successful growing of the grape in this part of Arkansas. Bordeaux mixture was applied once during the season, when the grapes were as large as peas or a little larger, but notwithstanding this application, the loss from rot amounted to fully one-third. A second application of Bordeaux mixture would probably have considerably diminished the amount of injury, and if the first had been made two weeks earlier, it would certainly have been much more effective. The experiments already made prove the unfitness of many varieties for this locality, but with far the greater number of varieties experimented with, only the experience of years can conclusively determine their fitness or unfitness for this climate.

VINIFERA.

With this class nothing but failure was to be anticipated. Neither of the two varieties planted have borne fruit, and but two of the ten plants surviving could possibly bear fruit next season. It seems probable that ten of the twelve plants originally planted will die without bearing fruit.

VULPINA.

None of this class have borne fruit yet, but the plants are usually extremely vigorous, and it is interesting to note that they are entirely exempt from the attacks of the leaf-folder. All the varieties of this class are direct descendants of the Muscadine of the south, which drops its berries when they are ripe and bears very few in a cluster, so that it is improbable that any of the varieties will prove of great value. If no satisfactory means of defeating the leaf-folder is found, it is possible that hybrids of the varieties of this class with some of the other species might be proof against the attacks of this much to be feared enemy.

AESTIVALIS.

Two varieties of this class, Cynthiana and Norton's Virginia, have succeeded very well, though neither bore a large crop.

RIPARIA.

This class, next to Labrusca, contains the greatest number of varieties which have succeeded well. Faith and Iron Clad head the list, both for size of crop and ability to resist rot. Black Pearl and Montifiore bore smaller crops, but they were even less affected by the rot, the first named being practically uninjured. Bacchus and Janesville bore at the rate of 1,100 pounds to the acre, but they were injured as much as 40 per cent. by rot. Grans Golden bore but 700 pounds per acre, but it is comparatively little injured by rot, and its fine appearance and excellent quality make it a very desirable variety for an amateur collection, if not for commercial purposes.

LABRUSCA.

To this class belong by far the largest number that will prove valuable for market grapes. They are almost always strong growers and some of them have resisted the rot well and have proven themselves excellent bearers. The following list of nineteen varieties is arranged with respect to productiveness, with the yield per acre given in pounds:

Cambridge	2,765	pounds	per acre.
Martha	2,382	"	" "
Wyoming Red	2,190	"	" "
Niagara	2,027	"	" "
Eva	1,843	"	" "
Mary Ann	1,770	"	" "
Ives	1,765	"	" "
Champion	1,702	"	" "
Amanda	1,361	"	" "
Rentz	1,269	"	" "
Dracut Amber	1,191	"	" "
Worden	1,134	"	" "
Rebecca	1,106	"	" "
Perkins	1,049	"	" "
Catawba	935	"	" "
Early Victor	773	"	" "
Moore's Early	748	"	" "
Isabella	664	"	" "
Hartford	603	"	" "

With respect to ability to resist rot, they may be divided into the following classes:

Per cent of injury by rot	0		
Champion	1,702	pounds	per acre.
Rentz	1,269	"	" "
Perkins	1,049	"	" "
Moore's Early	748	"	" "

Per cent of injury by rot		10
Martha	2,382	pounds per acre.
Mary Ann	1,770	" " "
Rebecca	1,106	" " "
Per cent of injury by rot		20
Cambridge	2,765	pounds per acre.
Wyoming Red	2,190	" " "
Ives	1,765	" " "
Worden	1,134	" " "
Early Victor	773	" " "
Per cent of injury by rot		30 to 40
Niagara	2,027	pounds per acre.
Eva	1,840	" " "
Dracut Amber	1,191	" " "
Catawba	935	" " "
Hartford	603	" " "
Per cent of injury by rot		50 or more
Amanda	1,361	pounds per acre.
Isabella.	664	" " "

It seems to me that the seven best grapes of this class, namely, Cambridge, Martha, Wyoming Red, Niagara, Eva, Ives and Mary Ann, after having withstood so successfully the severe test to which they have been subjected here, could be planted with strong assurance of success, but further experience will, of course, be required before the Station can recommend these as the best of their class, and then conclusions as to the comparative value of varieties are only valid for the locality or localities in which they were tested.

The term hybrid, as it has been used in the table, is intended to include crosses and seedlings whose parentage is questionoble as well as true hybrids. This class, as it is represented at the Station, includes a large percentage of worthless varieties. The fact is not surprising, of course, as most new varieties would naturally fall in this class. Nevertheless, the two highest yields, Munson's Hybrids, 33 and 65, yielded at the rate of 3,127 and 2,808 pounds per acre respectively.

The first was little injured by rot and the second was free from any sign of rot. Munson's, 38 and 50, were also free from rot and they gave 851 and 1,085 pounds per acre. Small yields, considering the fact that the crop was not diminished by rot, but the vines are young and will probably do much better after they have been in bearing a few years.

The Delaware was practically free from rot, but the yield was small, 783 pounds per acre. It has not proven a vigorous grower here. Black Eagle and Conquror gave 723 and 993 pounds of fruit per acre, but they were very seriously affected by rot and will prove good yielders if this disease is held in check.

Many old varieties and others that have been highly recommended have not succeeded well here. A few of these are named below, in order to call attention to them. The reason why they are considered to have failed can be ascertained by reference to the table. Beauty, Clinton, Concord, Duchess, Eaton, Elvira, Empire State, Goethe, Green Mountain, Herbemont, Lenoir, Pocklington, Poughkeepsie, Prentiss, Taylor, Transparent, Woodruff Red. While none of the classes except Vulpina were exempt from injury by the leaf folder, some varieties seemed particularly suited to their taste. These had not a leaf remaining after the second attack, while others were plainly shunned. Those which suffered most were Agawam, August Giant, Black Defiance, Black Eagle, Black July, Jefferson, Jessica, Montifiore and Prentiss. Marion and Berckman's were noticeably less injured than most others, while Northern Muscadine, Rentz and Telegraph were scarcely disturbed.

TABULATED FIELD NOTES ON GRAPES.

Varieties.	Class.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	Remarks.
Agawam	Hybrid	6	0	6	50	Aug 21	57	Berry large, bunch large and compact; leaf-folder bad.
Alvey	"	6	0	6	.....	.....	.....	No fruit.
Amanda	Labrusca	6	0	6	50	Aug 19-29	1301	Berry large, bunch large; compact.
Amber	.....	6	0	6	40	Aug 29	57	Berry large, bunch medium; loqse.
Amber Queen	Riparia	6	1	5	60	Aug 13-29	136	Berry large; poor yield.
Aminia	Hybrid	6	0	6	80	.....	.....	Three plants very weak. Berry large; very little fruit.
Anida	Labrusca	6	0	6	.....	.....	.....	.....
August Giant	Hybrid	6	0	6	70	Aug 13-22	312	Berry large. Leaf-folder bad.
Autuchon	"	6	1	5	.....	.....	.....	No fruit.
Bacchus	Riparia	6	0	6	40	Aug 13	1163	Bunch and berry medium. Quality not good.
Beauty	Labrusca	6	0	6	20	Aug 13-16	369	Berry small, bunch medium; very sweet
Berkman's	Hybrid	6	0	6	0	Aug 23-29	680	Quality rather poor. Foxy.
Black Defiance	"	6	1	5	10	.....	.....	Berry and bunch medium; compact. Leaf-folder bad. Did not ripen.
Black Eagle	"	6	0	6	70	Aug 1-12	723	Bunch large, berry medium.
Black July	Aestivalis	12	1	11	.....	.....	.....	No fruit.
Black Pearl	Riparia	6	0	6	0	Aug 1-18	1334	Berry med., bunch large.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Bottsi	Aestivalis	6	1	5	.....	.....	.....	Berry and bunch small. Very little fruit
Brant	Hybrid	6	0	6	.....	.....	.....	No fruit.
Brighton	Lubrusca	6	0	6	70	.....	.....	Berry med., bunch large. Fruit inconsiderable in amount.
Cambridge	Labrusca	6	0	6	20	Aug 7-16	2765	Berry large, bunch large.
Canada	Hybrid	6	0	6	90	Aug 22	113	Berry medium, bunch large.
Catawba	Labrusca	6	0	6	40	Aug 13–29	935	Berry large, bunch large.
Centennial	Aestivalis	6	1	5	70	Aug 22–29	340	Berry medium or small, bunch large. Quality excellent.
Challenge	Labrusca	6	0	6	10	Aug 1-13	688	Berry small, bunch medium.
Champion	"	6	0	6	0	Jul 28 Aug 18	1702	Berry medium to large, bunch small.
Clinton	Riparia	6	0	6	30	Aug 1-21	277	Bunch and berry medium.
Concord	Labrusca	6	1	5	50	Aug 13-22	647	Berry large, bunch large. Wormy.
Conqueror	Hybrid	6	0	6	50	Aug 11	993	Berry med., bunch medium. Wormy.
Cornucopia	"	6	0	6	100	.....	.....	
Cottage	Labrusca	6	0	6	30	Aug 13-28	425	Berry large, bunch medium. Wormy. Quality good.
Creveling	"	6	1	5	30	Aug 29		Berry and bunch large. Wormy. Two plants very weak.
Croton	Hybrid	6	0	6	100	.....	.....	Berry medium and bunch large.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Cunningham	Aestivalis	6	0	6	90	.....	.....	Berry medium and bunch small. Very poor yield.
Cynthiana	"	12	1	11	10	Aug 1-29	853	Berry small, bunch large. Two plants very small.
Delaware	Hybrid	6	1	5	0	Aug 13-29	783	.....
Diana	Labrusca	6	0	6	30	Aug 16-21	255	Berry medium or large, bunch large and compact.
Dracut Amber	"	6	0	6	30	Aug 16-29	1191	Berry large, bunch compact
Duchess	"	6	1	5	70	Aug 13	136	Berry medium.
Eaton	"	6	0	6	90	Aug 13-21	199	Berry of the largest size.
Early Victor	"	6	0	6	20	July 19-31	773	Bunch and berry med. to large. Quality good. Wormy.
Eldorado	Hybrid	6	3	3	20	Aug 16	369	Berry and bunch medium.
Elsingberry	Aestivalis	6	2	4	90	Aug 29	127	Berry small, bunch large. Very sweet.
Elvira	Riparia	6	0	6	30	July 31	227	Berry large, bunch medium; compact.
Empire State	Hybrid	6	1	5	.....	.....	.....	.....
Etta	Riparia	6	1	5	30	.....	.....	Berry medium to large, bunch large, compact. Little fruit.
Eumelan	Aestivalis	6	0	6	80	.....	.....	Berry medium and quality poor. Very little fruit.
Eva	Labrusca	6	0	6	40	Aug 16-21	1843	Berry and bunch large.
Excelsior	Hybdri	6	1	5	.....	.....	.....	All the plants very weak.

TABULATED FIELD NOTES ON GRAPES.—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Faith	Riparia	6	1	5	20	Aug 1-11	2178	Berry medium or small, bunch medium compact. Reddish white; sweet.
Florence	Labrusca	6	0	6	25	.....	340	.....
Flowers	Vulpina	6	1	5	.....	.....	.....	No fruit.
Gazelle	Hybrid	6	2	4	70	.....	.....	Berry medium; very little fruit. Surviving plants very weak.
Goethe	"	6	0	6	20	.....	.....	Berry and bunch large. Wormy. No marketable fruit.
Grein's Golden	Riparia	6	0	6	20	Aug 16-21	709	Berry very large and fine, bunch large and compact.
Green Mountain	.....	6	1	5	.....	.....	.....	No fruit.
Hartford	Labrusca	6	0	6	40	July 26 Aug 20	603	Berry and bunch large. Quality poor.
Hayez	"	6	0	6	.....	.....	.....	Berry med'm. Very little fruit.
Herbemont	Aestivalis	6	0	6	50	Aug 1-22	227	Berry small or very small, bunch large.
Herbert	Hybrid	6	0	6	40	.....	.....	But little fruit. The bunch and berry large.
Hermann	Aestivalis	6	0	6	70	Aug 16-29	340	Bunch large and compact, berry large.
Highland	Hybrid	6	0	6	.....	.....	.....	No fruit.
Humboldt	Riparia	6	0	6	50	Aug 29	188	Berry med., bunch med.; compact
Iowa	Labrusca	6	1	5	50	Aug 13-29	153	Berry med., bunch long. Sweet.
Iowa Excelsior	"	6	0	6	60	Aug 11-29	312	Berry med., bunch large.

TABULATED FIELD NOTES ON GRAPES—Continued.

Varieties.	Class.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	Remarks.
Iron Clad	Riparia	6	0	6	10	July 26 Aug 12	1815	Berry med., bunch med. to large. Sour.
Irving	Labrusca	6	3	3	80	.....	.....	Berry med. Very little fruit.
Isabella	"	6	1	5	80	Aug 8-16	664	Berry large, bunch large and long.
Isabella	"	6	1	5	80	.....	.....	Berry small, bunch medium.
Ives	"	6	0	6	20	Aug 1	1765	Bunch and berry large.
Janesville	Riparia	6	0	6	40	Aug 1-12	1149	Berry large, bunch medium.
Jefferson	Labrusca	6	0	6	20	Aug 22	28	Bunch large, berry med. to large. Leaf-folder bad.
Jessica	Hybrid	6	3	3	30	Aug 21	397	Berry med , bunch large. Leaf-folder very bad. White very good.
Lady	Labrusca	6	0	6	30	Aug 8-16	333	Berry med., bunch med. and compact.
L'dy Washingt'n	Hybrid	6	1	5	50	Aug 16	272	Bunch very large, berry med. to large.
Lenoir	Aestivalis	6	0	6	90	Aug 29	14	Berry small.
Lindley	Hybrid	6	1	5	60	Aug 11-29	496	Berry large, bunch medium.
Louisiana	Aestivalis	0	1	2	30	.....	.....	Bunch small and very compact. Very little fruit.
Marion	Riparia	6	0	6	40	July 26-31	673	Bunch med., berry large or med. Little injured by leaf-folder
Martha	Labrusca	6	1	5	10	Aug 1-21	2382	Berry large, bunch medium or large.
Mary Ann	"	6	1	6	10	July 23 Aug 12	1770	Berry large and long bunch large. Sour.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Massasoit	Labrusca	6	0	6	80			Berry small, bunch large. Sour.
Mason's Seedl'g	"	6	1	5	40	Aug 16	170	Berry large, bunch medium.
Maxatawney	"	6	0	6	70	Aug 16	156	Berry med'm, long.
Merrimac		8	0	6	70	Aug 13-14	269	Berry large.
Mo. Riesling	Riparia	6	0	6	40	Aug 21	57	Bunch med., compact, berry medium.
Mission	Vinifera	6	2	4				Two of the surviving plants are very weak.
Montefiore	Riparia	6	0	6	10	Aug 1-28	1347	Berry large, bunch medium and compact. Leaf-folder bad.
Moore's Diam'd	Labrusca	6	0	6	10			Berry large, quality good. Very little fruit.
Moore's Early	"	6	1	5	0	July 26 Aug 13	748	Berry large or very large, bunch compact. Quality very good.
Meyer		6	0	6	20			Berry and bunch large. Very little fruit.
Munson's 15	Hybrid	2	0	2	10	Aug 21	85	Rather poor quality.
" 25	"	2	0	2	0			
" 26	"	2	1	1	10	July 31	170	
" 27	"	2	0	2	0	Aug 21	340	
" 33	"	2	0	2	10	Aug 7-11	3127	Berry and bunch medium.
" 38	"	2	1	1	0	Aug 21	851	Large berry of excellent quality.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Munson's 41	Hybrid	2	0	2	30	Aug 21	85	Quality excellent.
" 45	"	2	0	2	40	July 26	85	
" 47	"	2	0	2	0	Aug 28	340	
" 50	"	2	0	2	0	July 23	1085	
" 51	"	2	0	2	0			
" 65	"	2	0	2	0	Aug 22-29	2808	Berry medium to large.
" 67	"	2	0	2	0	Aug 21	170	
" 71	"	2	0	2	0	Aug 21	425	Sweet. Seed free from pulp.
" 126	"	2	0	2	0	Aug	255	
Naomi	"	6	4	2	0	Aug 29	340	
Neosho	Aestivalis	6	6	0	0			
New Haven	Labrusca	6	1	5	20	Aug 7-22	570	Berry and bunch large. Surviving vines very weak.
Niagara	"	6	0	6	40	Aug 1-21	2027	Berry medium to large, bunch large.
Noah	Hybrid	6	1	5	0	Aug 28	174	Bunch large. Leaf-folder very bad.
North Carolina	Labrusca	6	0	6	30	Aug 12	170	Berry large to very large, bunch large.
N'thn Muscadine	"	6	0	6	60	Aug 13-21	421	Berry large, bunch medium. Very little hurt by leaf-folder. Wormy.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Norton's Virginia	Aestivalis	6	0	6	30	Aug 13-29	851	Berry small, bunch med. Quality poor.
Oriental	Hybrid	6	0	6	60	Aug 14	170	Berry and bunch large.
Othello	"	6	1	5	80	Aug 13-29	289	Bench and berry large.
Pauline	Aestivalis	6	0	6	90			Two plants very weak.
Pearl Rounnels	Riparia	6	0	6	70	Aug 21-22	132	Berry small or medium. White berry very good.
Perkins	Labrusca	6	0	6	0	Aug 14-22	1049	Bunch and berry large. Quality doubtful.
Peter Wylie	Hybrid	6	1	5	0			Berry med., bunch med. compact. Little fruit.
Pocklington	Labrusca	6	0	5	70			Berry large. Fruit not measured.
Poughkeepsie	Hybrid	6	1	5	0			No fruit.
Prentiss	Labrusca	6	0	6	70	Aug 21	70	Berry medium or small, large compact bunches. Leaf-folder bad. Sour.
Rebecca	"	6	3	3	10	July 19-30	1106	
Rentz	"	6	0	6	0	July 26 Aug 12	1269	Berry large, bunch med. Little inj'y from leaf-folder. Wormy.
Requa	Hybrid	6	0	6	60	Aug 29		Berry large, bunch medium. Little fruit.
Rochester	Labrusca	6	1	5	60	Aug 12-29	408	Berry and bunch large.
Rogers' 2	Hybrid	12	0	12	80			Berry large, bunch large. Little fruit.

TABULATED FIELD NOTES ON GRAPES—Continued.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMARKS.
Rogers' 5	Hybrid	6	0	6	10	Aug 20	340	
" 8	"	3	0	3				
" 11	"	6	2	4	30	Aug 22	43	
" 13	"	6	0	6	0	Aug 12–22	170	
" 14	"	6	0	6	0	Aug 16-22	369	
" 36		6	0	6	0	Aug 22-27	128	Large black berry of good quality.
Salem	Hybrid	6	0	6	50	Aug 16	57	Berry large, bunch medium.
Secretary		6	0	6	80	Aug 12	113	Berry long and large, bunch long.
Scuppernong	Vulpina	6	0	6				No fruit.
Taylor's Bullet	Riparia	6	1	5	0	Aug 21	238	
Telegraph	Labrusca	6	0	6	60	July 26 Aug 12	319	Berry large, bunch med. Little injured by leaf-folder.
Thomas	Vulpina	6	3	3				No fruit.
Transparent	Riparia	6	1	5	0	Aug 5-29	290	Little fruit. Surviving plants weak.
Triumph	Hybrid	6	0	6	40			Berry med, bunch large.
Uhland	Riparia	6	0	6	80	Aug 29	28	Berry and bunch medium.
Ulster Prolific	Labrusca	6	1	5	0	Aug 16-22	306	

TABULATED FIELD NOTES ON GRAPES—Concluded.

VARIETIES.	CLASS.	Number of Vines Planted.	Number of Vines Dead.	Number of Vines Living.	Per cent of injury due to Rot.	Fruit Ripe.	Yield lb. per Acre.	REMASKS.
Venango	Labrusca	6	0	6	60	Aug 29	142	Berry large, bunch medium.
Vergennes	"	6	1	5	0	Aug 13-29	613	One plant very weak. Seed separates easily from the pulp.
Waverly	Hybrid	6	1	5	.....	.....	.....	No fruit.
Whitehall	Labrusca	6	0	6	70	Aug 26	113	Berry large, bunch large. Wormy.
Wilder	Hybrid	6	1	5	60	Aug 13-22	442	Berry and bunch large.
Wilding	"	6	1	5	10	Aug 18-21	510	Berry large, bunch medium.
Woodruff Red	Labrusca	6	0	6	100	.....	.....	Berry very large, and bunch compact. Quality very good.
Worden	"	6	0	6	20	Aug 5	1134	Berry and bunch large. Two plants very weak.
Wyoming Red	"	6	0	6	20	July 26 Aug 19	2190	Berry med., bunch large. Quality excellent.
York Madeira	"	6	1	5	30	Aug 16-29	289	Berry and bunch medium. Two plants very weak.
Z'nfa idel	Vinefera	6	0	6	.....	.....	.....	All very weak. No fruit.

SPECIAL ENTOMOLOGIST'S REPORT.

THE ACTION OF SOME NEW INSECTICIDES ON THE COTTON WORM.*

The present season has not been a very desirable one for experimental work on the cotton worm. It was not until late in September that they appeared in sufficient numbers to experiment with, and then only on an acre or two of land. This was at Noble Lake; and when the report of their work reached me, they had already commenced to "rag" the leaves, and had almost entirely disappeared inside of a week. The field experiments had to be made at this time and supplemented later by experiments on the cotton worms in confinement, to watch more closely the action of the insecticides upon them. Owing to the disadvantages under which we were thus placed, and to the lateness of the season, the experiments were not so complete in all respects as it was desired to make them. In the work, it has been our aim to find some practical remedy for the cotton worms that will have the desired effect on them, and at the same time not be as dangerous to the handlers as Paris Green and London Purple.

LIQUID REMEDIES.

SLUDGE.

The experiments were devoted as much as possible to the use of poisons in the powder form, as this seems to be the more desirable.

*During the present season our Staff Entomologist was taken sick with malarial fever at Pine Bluff. We therefore secured the services of Mr. G. C. Davis, Entomological Assistant at the Michigan Agricultural College, to undertake some experiments with the cotton worm. It occurred to me that it might be a good plan to test several chemicals as to their insecticidal properties. I prepared several substances for trial, in each case mixing the chemical with an amount of flour that would bring the price of the mixture to that of Paris Green. The results obtained by Mr. Davis with these mixtures appear in the succeeding pages. I am at present determining the active principle of Pyrethrum, and the kerosene extract described was obtained by me in the process. It will of course be possible to make this any required strength by means of a suitable extraction apparatus. We intend to continue this work. We shall also experiment next season with other alkaloids, as Veratrin seems to have been quite effective.

ALBERT E. MENKE, Director.

A few insecticides to be applied as liquids seem sufficiently promising to deserve some attention. One of these is the kerosene soap, commonly known as sludge, made from a refuse in the refining of coal oil. This is a cheap insecticide, and had proved effectual on the pear tree slug and some other insects. It, nevertheless, proved a failure on the cotton worm, although applied as strong as it could be made without solidifying when cold.

KEROSENE EXTRACT OF PYRETHRUM.

This is an entirely new insecticide, and from present indications seem to be one of the most efficient and at the same time inexpensive and harmless remedies that we have. It combines the strength and destructive elements of two well known insecticides, pyrethrum and kerosene oil, in one.

The proportions of pyrethrum and kerosene were two and one-half pounds of the former to about one and one-half gal-

lon of the latter. The yellowish, oily extract obtained will not mix with water any more readily than pure kerosene and has to be formed into an emulsion with soap in a manner similar to the kerosene emulsions. Quite a number of experiments were made to ascertain the best proportions to use in making the emulsion, and it was found to be one pound of soap dissolved in one gallon of boiling water, and to this boiling hot mixture, add one gallon of the kerosene extract and mix with a force pump so thoroughly that the oil will not separate on standing. This will require from ten to thirty minutes steady work, according to the quantity and the force used. On cooling, the emulsion will be a thick creamy mass which can be diluted with water to the desired proportions.

Experiments were conducted to ascertain the least amount that would be perfectly effectual when applied to the cotton worm, and the summary is, that it is one part of the emulsion to 450 or 500 parts of water. When it was diluted with more than 900 of water the young worms were not killed; at a strength of 500 to 900 parts of water to one of emulsion, those half grown or less seldom escaped death. When reduced much less than one part in 450 death came in a very few minutes. The application of one part to 500 of water caused the worms to die in from twelve hours to two days, according to size. This proportion was also tried on pupæ. All those that were exposed by an opening in the web or leaf sufficient to be wetted by the solution were killed quite quickly, otherwise they were uninjured.

The extract kills entirely by contact and not by eating, as with Paris Green and London Purple. It makes the cotton worms uneasy as soon as applied and causes them to drop to the ground writhing in great agony. This continues until they become greatly exhausted, when they often remain motionless for some time before death. While the emulsion is so destructive to insect life, it is not in the least injurious to those handling it.

A very important feature of this extract as an insecticide

is its cheapness. The cost of that used this season is as follows:

2½ pounds pyrethrum @ 30 cts. per lb	$0.75
1½ gallon oil @ 15 cts. per gal	.22½
1½ gallon extract, cost	.97½
1 gallon extract, cost	.65
1 pound soap, cost	.10

In spraying, thirty gallons of the diluted emulsion is generally considered the amount necessary to cover an acre of cotton. This is made up at a strength of 1 part to 450 of water, therefore 75 cents will buy enough for 15 acres. It is a minimum price for an insecticide, and its cheapness, combined with its other good qualities, is bound to make it a very popular remedy for many insects.

The exact strength at which it can be applied to plants without injury to the foliage was not determined, but was experimented with enough to know that it can be used quite strong without any perceptible harm.

Although the cost of this insecticide is so small the application of the emulsion to large areas will have an increased expense due to the necessary spraying machinery. This might be lessened if it could be applied in the powder form. Further, water for extensive spraying is sometimes difficult to obtain close at hand. Considering these difficulties, it was thought that possibly the extract could be mixed with some powder so that it could be dusted on the plants. Several experiments were made to test its practicability.

The ashes used in the following experiments were fresh, and as dry as could be obtained. They were screened through a wire sieve and then through very fine sacking, leaving them very fine, so much so that a light breeze would carry them quite a distance. The experiments as tried are:

1. One-fourth pint of kerosene extract to one pound of wood ashes, applied immediately after mixing. All the worms were more or less affected, but the larger ones soon commenced feeding again, and the next morning all had recovered.

2. One-half pint kerosene extract to one pound wood ashes, applied after mixing. A few of the worms died in three quarters of an hour; the others survived after two days.

3. Five-eighths of a pint of kerosene extract to one pound of wood ashes, applied when first mixed. All but one large worm died in thirty-five minutes and that one died an hour later.

4. Three-fourths of a pint of kerosene extract to one pound of wood ashes, applied when first mixed but very wet. Result, all dead inside of fifteen minutes.

5. One-half, five-eighths and three-fourths pint were mixed respectively in one pound quantities of wood ashes and placed in an oven a few minutes till moderately dry. The substance thus obtained had no odor and did no injury to the cotton worms.

6. Refuse pyrethrum powder from which the extract was made. No effect.

7. Same as No. 6, with one-fourth of pint of kerosene extract to the pound added. This was effectual in its work, but was too wet to apply well. When dried not as satisfactory.

Experiments with the extract in coal ashes, cotton-seed meal and flour were tried, but with results not entirely satisfactory. Cotton-seed meal is too coarse and flour not of the right nature to admit of the mixture. The coal ashes retained the extract better than the wood ashes, but were too wet to be applied when first mixed and lost much of their strength when dried. Mixture No. 3 proved the most satisfactory, as this was dry enough to dust on the plants, and killed the worms; when mixed with a small amount of dextrine the ashes adhered well to the plant.

OTHER POWDER FORMS.

Of the other powder forms of insecticides tried, all were mixed with about one pound of flour and were applied both heavily and lightly to the plants to note the different effects.

Quite a number proved of no value. None of these powders injured the plants on which they were applied.

One ounce of Santonin to one pound of flour..... No effect.
Eight ounces of Oxalic Acid to one pound of flour .....
One ounce of Benzoic Acid to one pound of flour.....
Two ounces of Mercuric Chloride to one pound of flour .....
One ounce of Tartar Emetic to one pound of flour.....
One ounce of Salicylic Acid to one pound of flour.....

One ounce of Cinchonin to one pound of flour.—When this was heavily applied to the plant the leaves were eaten without injury to the larger worms, while the smaller ones were usually killed in about twenty-four hours. Some of the larger worms "webbed up" after eating, and died before transforming to the pupæ state. All showed signs of considerable disturbance after eating the dusted leaves.

Eight ounces of Bichromate of Potash to one pound of flour.—When lightly applied in the field this seemed to do no perceptible harm. When applied heavier, the worms refused to eat the leaves. Some were confined in a box and kept constantly supplied with fresh leaves covered with the powder. After two days fasting one worm ate a small notch in a leaf and soon died from the effects. The others starved to death in about a week.

Hellebore had very much the same effect as the preceding on the worms, causing them to "web up" if possible, and if not, to eat some fresh leaf not dusted, or starve. The dust of the hellebore seemed to affect the breathing, as it caused an uneasiness when first applied.

Eight ounces of Lead Acetate to one pound of flour.—As a remedy, this did not prove very satisfactory, although it killed some worms, both in the field experiments and in confinement, which merits it to still further trial. This powder kills by eating, soon causing the worm to leave the plant and writhe until dead.

One-fourth ounce of Veratrin to one pound of flour.—Although in the proportion of one part of the chemical to 64 of flour, this powder was by far the most effectual in its work of

any tried, and bids fair to be a rival of Paris Green and London Purple. It kills by contact and by eating. When it comes in contact with the worm, there at once begins to be a marked uneasiness followed almost immediately by trembling and writhing, during which it falls to the ground probably never to recover. Should it recover sufficiently to return to the plant, as soon as it begins eating, a small quantity proves fatal. Some experiments with Paris Green were made under like conditions for the comparison of the two, with the exception that the Paris Green was applied in the strength that it is usually used. There seemed to be, in general, a considerable similarity in effect, except that the Veratrin showed more effect by contact, and the Paris Green seemed somewhat quicker in its effects when eaten.

Experiments were also made to ascertain the quantity of Veratrin necessary to be effectual. As near as could be determined, it will require from a pound and a half to two pounds of the mixture per acre. The data obtained as to best quantity to be used or strength of mixture, are insufficient to warrant conclusions on these points. The poison, as made up by Prof. Menke might have been more diluted with flour and still proven effectual. We had not the chance this year to complete these tests. The cost of the insecticide mixture will, when purchased on a large scale, be about the same as Paris Green. Veratrin is but little used at present except in medicine.

SUMMARY.

Kerosene extract of pyrethrum proves to be a powerful insecticide. It is made by passing kerosene oil through the powdered pyrethrum. Combined with soap it forms an emulsion which may be reduced to one part in 450 or 500 parts of water before applying. It is harmless to those who handle and apply it, and costs about five cents per acre. The application of it in the powder form combined with ashes, cotton seed meal, refuse pyrethrum powder and flour were hardly satisfactory enough to recommend the use of it in that form.

Veratrin is a quick and effectual exterminator, killing by contact and by feeding. Although greatly diluted, it proves itself nearly, if not entirely, equal to Paris Green. The cost of the mixture is about the same.

OBSERVATIONS.

Many have wondered why the cotton worm did not increase more rapidly this season. A few observations made in the field may show some reasons for their small number.

1. The blackbirds frequented the cotton fields very closely through the season, and did a great deal toward keeping the plants free from worms. The flocks were very numerous, and in several places where quite a few worms could be found before an invasion, the plants would be practically free after it.

2. Ants were seen to attack the worms on the ground and the leaves of the plant, usually with success. The species appeared to be the *Solenopsis geminata*.

3. The Spined Soldier Bug (*Podisus spinosus*) was very numerous this season in all stages of growth and did good work as usual.

4. *Deræocorus rapidus*, known commonly as the Dusky Plant Bug. This evidently is also a plant feeder, as Professor Forbes mentions it* among the insects injurious to the strawberry, and it

6. The parasites also did their share. The little egg parasite, *Trichogramma pretiosa*, which is said to destroy such a large per cent. some years, was not found till late in September. From that time on it probably destroyed nearly one-fourth of the eggs.

7. Quite a per cent. of the pupæ of the second brood was parasitized by *Chalcis oratus*.

8. Later in the season fully one-fourth of the worms were attacked by that peculiar parasite known as *Comstock's Euplectrus*.

Just how much these enemies of the cotton worm have done to prevent ravages similar to those of last year, cannot be definitely stated, but it is certain that, had the worms not been molested by them this season, the cotton would have been greatly injured in many places.

G. C. DAVIS, Special Agent.

Pine Bluff, Ark.

*Illinois Agricultural Report, 1883. Entomological Report, pp. 135-8.

STAFF ENTOMOLOGIST'S REPORT.

ARTICLE I.—NOTES OF THE SEASON.

The past year has been comparatively free from insect injury. Local losses however have sometimes been serious.

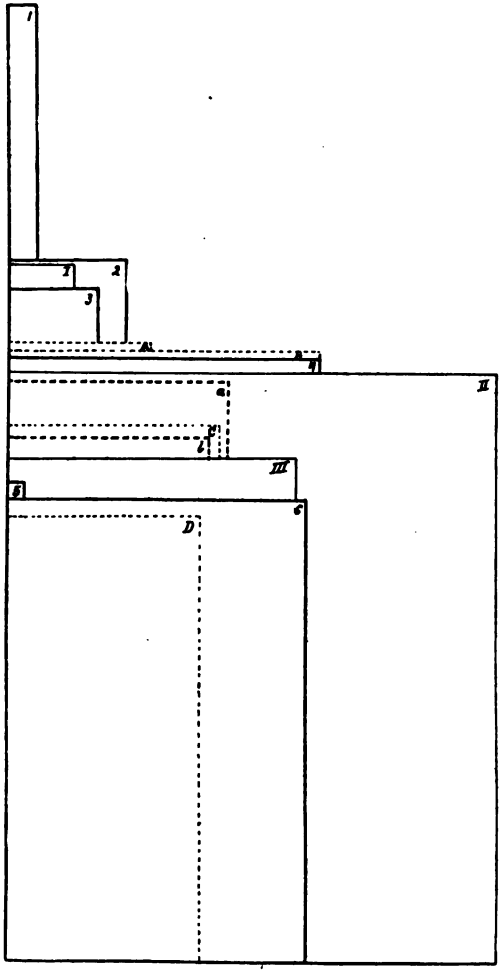
Cutworms.—The warm winter seems to have been very favorable to the hibernation of cutworms. All over the southern part of this State as well as in Texas and Louisiana they seem to have been more numerous than usual. The real damage they do in the field is generally much less than would be the cost of any remedy at present known. Clean cultivation as a preventative measure is an exception only because it pays for other reasons. On garden plots the use of poisoned baits certainly will pay and when the worms are very abundant it is probable that it might be used to advantage even on a large scale. The poisoned baits consist of clover grass or any other green herbage dipped in a solution of Paris green or any other arsenite and scattered in bunches on the ground after the latter has been plowed and harrowed in order to remove everything else the worms could find to feed on.

White Grubs.—The young of the "June bug" is the insect known as the white grub. It did a great amount of damage in some limited localities and the mature insect was very abundant. Where this was the case they should be looked out for the coming season. As for remedies what has been said in reference to the cut worm is equally applicable for this insect.

The Grain Plant Louse.—This insect did considerable injury last year as noted in the Second Report but was even more injurious the past season. Indeed they probably did more injury than any other one insect attacking field crops. Some experiments tried this season gave only negative results, due in part at least to the presence in large numbers of several species of "Lady Beetles" which were a more effectual check to the insect than the remedies tried. It is probable that these beetles have

so nearly exterminated the lice that they will not be able to do any injury next year.

The Grape Leaf Folder.—While most of the vineyards about here were not seriously troubled by the leaf folder the experiment vineyard of the Station became very much eaten.



A marked difference in the amount of injury done to different varieties was observable. The following varieties lost more

than three-fourths of their foliage: Agawam, Brighton, Diana, Excelsior, Grein's Golden, Herman, Highland, Israella, Jefferson, Jessica, Lady Washington, Mary Ann, Mason's Seedling, Merrimac, Montifiore, Munson's No. 15, 27, 41, 45, 50 and 67, Naomi, Prentiss, Requa and Rogers No. 2, 5, 8 and 11.

Those that lost more than one-half of their foliage are: August Giant, Beauty, Brant Centennial, Champion, Concord, Cunningham, Devereux, Elvira, Etta, Goethe, Hayes, Herbert, Mission, Missouri Riesling, Munson's No. 25, 26, 38 and 71, Othello, Perkins, Rebecca, Rochester, Rogers No. 36, Telegraph, Triumph, Vergenes and Zinfandel.

Those that had less than half of their foliage eaten but still more than one-fourth are: Amber, Amber Queen, Black Eagle, Cornucopia, Cottage, Cynthiana, Delaware, Early Victor, Eaton, Eumelan, Florence, Herbemont, Iona, Ives, Lady, Lindey, Massasoit, Niagara, North Carolina, Northern Muscatine, Pearl, Rogers No. 13 and 14, Ulster Prolific and Wilder.

Finally those but little affected, less than one-fourth, are: Anida, Bacchus, Black Pearl, Clinton, Duchess, Elsingburg, Flowers, Hartford, Marion, Martha, Moore's Early, Scuppernong, Taylor's Bullet, Thomas and Woodruff Red.

The accompanying diagram Fig. 1, shows graphically the per cent of the foliage not destroyed by the leaf folder. For instance the tallest rectangle indicates that all the leaves were free from the worms. A rectangle half as high would indicate that half the leaves had not been eaten by the worms and so on. As these results are more liable when they are the average of a large number of varieties, the diagram is constructed so as to indicate by the width of the rectangles the number of varieties in each case. The widest rectangle represents fifty-one varieties and the rest in proportion. The rectangles bounded by the heavy lines and marked by Arabic numerals show the relative immunity of the different classes of grapes. The classes are numbered as follows: Vulpina 1, Riparia 2, Aestivalis 3, Labrusca 4, Vinifera 5, and Hybrids 6, the latter being the most affected and the Vulpina least or rather not at all. The lighter

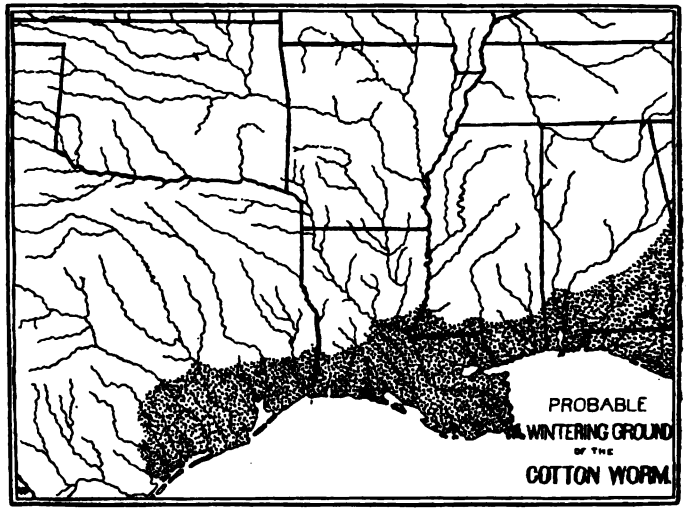
lines and Roman numerals indicate the relation of the character of growth and the injury. The data as to growth is that recorded by Prof. Richman our former Horticulturist in the first report of this Station. *1*, includes those recorded as making a poor growth; *2*. those that made a good growth, and *3*. a fair growth. Taking data from the same source we compare the injury due to the leaf folder and the susceptibility of the plants to mildew. The light dots and capital letters indicate this relationship. A. and B. which indicate slight and no injury respectively are very nearly equal in the amount of injury by leaf folder. C. represents those quite badly affected by mildew and which became so during July, while D. represents those that became badly affected only during the wet weather of September. The heavy dotted lines marked with small letters show the relation between the injury of the leaf folder and that of the arsenites as recorded in Bulletin 14, *a* showing the varieties having less than the average amount of injury and *b* those having more.

These comparisons show some very interesting facts. There must be some property or properties of the leaves, structural or otherwise, which render them distasteful to the worm. This is particularly the case of the grapes of the Vulpina class, the Hybrids on the other hand are particularly attractive to the worm. Will it not pay the originators of new varieties of grapes to bear these facts in mind and to select and propagate plants which have this peculiarity?

The Cotton Worm:—The past year has been a season of almost no injury in this State and the probabilities are that we need not fear them the coming season. The work done this year on the worm is recorded in Articles Two and Three of this Report.

The Boll Worm:—Only a comparatively small amount of injury was done by this pest. We announced last year that it was the intention of the Station to investigate this insect the

coming season but as the United States Department of Agriculture has taken it up we will not attempt anything in that line.



ARTICLE II.—COTTON WORMS.

The great amount of damage done by the cotton worm in 1889, made it a subject of more absorbing interest in this State than any insect that had ever troubled our farmers. In order to impress them with the necessity of action, and to make them acquainted with the best means of procedure, a circular was issued from this office towards the latter part of the year, suggesting that conventions of farmers be called in all parts of the State to discuss the subject. The idea was taken up by the papers and also ably seconded by the Commissioner of Agriculture, Col. Locke, and by our Governor. A local convention at Alma, in December, and a State convention at Little Rock, in January, was the result.

We were in attendance at both conventions and presented an account of the known life history, remedies, etc., as given in the Second Report of the Station. We tried to emphasize the fact that the cotton worm in this State is only a summer visitor, that the real solution of the problem cannot be worked out in this State, but that the States bordering the Gulf must be

the battle ground. It is a fact that we should thoroughly understand that Arkansas only suffers through the carelessness of our more southern neighbors.

In the accompanying map we have attempted to represent the region where the moths that reach Arkansas come from, where the insect passes the winter and matures its earlier broods. The boundary of this region is only approximately known, and the Station put forth earnest efforts to get data on this point by correspondents, but secured scarcely anything of a reliable nature. It seems to require the labor of an entomologist on the ground to obtain positive results. Attempts to trace the insect in its migration proved futile this year on account of its extreme scarcity.

To secure these objects the Station solicited the aid of reliable men in each county in the cotton growing region of this State and the States south of us, and we would here acknowledge the great obligations we are under for their services which were rendered freely and without compensation. In bulletin 12, having the date of April, 1890, but which, on account of delay in printing did not appear for over a month, we gave the following statement of the outlook:

COTTON WORM PROSPECTS.

"A considerable amount of fear is expressed by correspondents in agricultural papers concerning the probability of a serious loss this year from cotton worms.

Among the causes of this uneasiness seems first to have been the apprehension that the remarkably long winter we had would allow the moths to hibernate in excessive numbers. This idea was emphasized by some at the Cotton Worm Convention, held at Little Rock in January, and something of the kind was expressed in the resolutions there adopted, despite our strenuous opposition. The facts of the case seem to be that a warm winter is by no means the best for the hibernation of the moth. We do not think that an especially warm winter has ever been followed by a bad cotton worm year.

"Another point discussed at the same convention was the

statement made by the chairman and several other extensive planters, that the cotton worm moth was even then to be found in great numbers on their plantations. If the moths would hibernatethe past winter as far north as Central Arkansas, we certainly would have great cause for alarm. Of course we expressed at once our doubt of the determination, and some specimens were then submitted to us which were moths belonging to an entirely different family. After the convention more were sent us from different plantations, and others sent to the Department of Agriculture at Washington, but none of them proved to be the real cotton worm.

"A third cause of alarm is founded on the belief that the cotton worm passes the winter under ground as a pupa. Some of those holding to this theory do not distinguish between the cotton worm and the boll worm, while others suppose a curious change of habit of the cotton worm at the approach of winter. It will suffice to say that this latter hypothesis is a mere speculation without foundation in observation, and that the pupæ sent us this year, and more especially the great numbers sent to the Department at Washington during the last score of years, fail to give it any support.

"What at the present time seems to cause the most alarm is the presence of a great number of moths, especially in Texas, which are confidently believed to be cotton worm moths. For the encouragement of planters we can say that there is really small cause for alarm. To show what weight this statement has, we will state that this Station has secured the services as correspondents, of a large number of good, reliable men in this State and in Mississippi, Louisiana and Texas, who will keep us informed as to the presence and numbers of the worms. We have received from these correspondents, specimens of the moths that are supposed to be the cotton worm moths, but none of them have proven to be that insect. The following announcement has been quite widely circulated through these States, and the fact that the reward is still open, proves how extremely scarce the cotton worms and moths are.

COTTON WORM MOTHS.

"Desiring to make out with certainty the wintering grounds of the cotton worm, the undersigned will give $5.00 reward to the first person sending a real cotton worm moth, taken alive this year, in the State of Arkansas, Mississippi, Louisiana or Texas.

"They are mostly to be found under the shelter of rank wire grass, and may also be found about gin houses or any other suitable shelter. Many other moths are to be found in the same situations. They should be sent in a small tin or wooden box, and accompanied by a letter, giving the place and circumstances of its capture.

"There are some who still believe that the cotton worm passes the winter in some other form, and to them I will say that I will offer the same reward to the first one sending a living specimen of any other stages. There is no likelihood of any one earning this second reward till the first spring brood of worms appear.

"Address all specimens and communications to C. W. Woodworth, Entomologist, Arkansas Agricultural Experiment Station, Fayetteville, Arkansas."

It will be thus seen that as far as the cotton worms are concerned, the planter has, so far this year, a promising outlook, but it is not out of place to say something as to remedies. Paris Green and London Purple are about the sum of practical remedies for the summer, and as a whole, between the two, there is not much to choose. In their application, the following points should be considered:

1. *Do not apply except when needed.* This useless waste of time and poison one sees during every cotton worm scare. It is useless to poison a whole plantation when, as is often the case, the worms are confined to a small patch or two.

2. *Do not apply too much poison.* A pound or even a half pound to the acre is enough to kill all the worms that are ever found there.

3. *Do not let a field or spot become ragged.* Watch the

fields carefully and be prepared to poison as soon as the worms become at all threatening.

4. *Apply the poison evenly.* One pound all over the acre is infinitely better than ten pounds scattered around in spots. Be sure you poison every plant.

Though this bulletin did not appear for a month as above stated, the situation remained the same. This article was quite freely copied by the newspapers and so gave still wider circulation to the reward offered for the worm or moth, but we failed to receive specimens of them until they had reached this State. Quite a collection of sizes and kinds of insects were sent, sometimes even belonging to different orders, but they were generally cut-worms or cut-worm moths. Not until July did anyone secure the reward when a colored man near the branch station south of Pine Bluff found a worm in the fields there. No bona fide cotton worm moth was sent me at all.

Our experiment to test the practicability of a system of warnings for the cotton worms was entirely successful. The plan seems to be entirely feasible. We were enabled to predict the lateness of the attack and the small numbers of the worm. A reliable prediction could be made at least a month and probably even two months before the worm became troublesome. Enough to enable the planters to provide themselves with the poison and be ready for them. The crop could always be saved in this way.

The data upon which to base these predictions must be obtained from a large number of reliable men all through the region to the south of us. The larger the number of correspondents the more reliable will be the predictions. We furnished our correspondents to the number of several hundred with Postal card blanks of the following form:

Form B.

TO BE MAILED ON FIRST APPEARANCE OF THE WORM.

.....189....

1. **Where and by whom were the worms discovered?**.....

.....

2. **Is the determination reliable? (Send specimen if you can)**.....

.....

3. **What is the size of the worms?**.....

4 **Where was it first observed last year in your county?**.....

.....

5. **How is the crop and weather?**.....

.....

.....

..... **Signed**.....

When these blanks alone are used however one is never certain of the determination. The great variety of worms that farmers will pronounce the cotton worm is almost beyond belief. A better plan would be to furnish a box stamped and addressed ready for mailing and containing the following blank.

COTTON WORMS.

From .....

Town .....

County .....

State .....

Date ....1891.

When a correspondent sends a wrong insect he can again be supplied with a box. After it is determined that the worm occurs at a given place the correspondent should be supplied with a set of postal card blanks to make regular reports as often as twice a month. The form used by this Station will be found quite satisfactory.

Form E

TO BE MAILED.

[Please indicate by underscoring the proper words below. Give per cent of each size of worms]

CONDITION.

EGG.	WORM.	MOTH.
None seen.	[Size]	None seen.
A few.	Small ..... %	A few.
Numerous.	Large ..... %	Numerous.
Very many.	Webbed up..... %	Very many.

ABUDANCE OF THE WORM.

IN SPOTS.	WHOLE FIELDS.	EVERYWHERE.
A few.	A few.	A few.
Numerous.	Numerous.	Numerous.
Destructive.	Destructive.	Destructive.

WEATHER.—How has it been since last report?

.....

.....

.....

CROP.—Give general condition.....

.....

.....

.....

Signed .....

The date on the first line was filled in with a rubber dating stamp and a set sent wherever the worm appeared, to be filled out and returned the 1st and 15th of each month till the middle of September, when it is no longer important to follow the worm.

The Station intends to keep the farmers informed of the situation the coming season but it will soon come to be no longer an experiment and outside of the legitimate work of an Experiment Station. It is something that can be of great value to the farmer and should be maintained.

ARTICLE III.—EXPERIMENTS WITH ARSENITES.

We may look on agricultural entomology as the science that has to do with the diseases of cultivated plants caused by insects. Like Medicine, one of the most important subjects with which it has to deal is that of the effects of the remedies used. The arsenites are the most important insecticides in use, but they are often accountable for a great amount of injury to the foliage. It is not uncommon to hear planters say, "The poison hurt me more than the worms." Of course it can be answered that the poison was applied too thickly or unevenly, but still the fact is patent that two applications made by the same method and as nearly alike as possible will sometimes seriously injure in one case and not at all in the other.

Our present knowledge of the cause, and therefore the way to prevent the injury, is very meagre. Perhaps I cannot do better to show what is known than to quote the conclusions of four investigators on this subject.

Prof. Riley, the United States entomologist, says*: "Certain trees are more susceptible to the corrosive effects of the arsenic than others. After each rain the poison takes a new effect upon the plant and the pest, which indicates that the poison is absorbed more, or is more active when wet, and that it acts by dehydrating thereafter. The poison not only produces the local effect from contact with the parts touched by it, but following this there appears a more general effect, manifested in that all the foliage appears to lose, to some extent, its freshness and vitality. Slight over-poisoning seems to have a tonic or invigorating effect on the trees."

Prof. Cook, of the Michigan Experiment Station, sums up his experience as follows†: "London purple is more injurious to the foliage than is Paris green, and white arsenic (arsenious acid) is more harmful than either London purple or Paris green. Peach foliage is especially susceptible to injury, and cherry foliage the least so of any of the kinds treated. It would seem that London purple and white arsenic used just be-

*U. S. Agricultural Report for 1886.
†Bulletin 53, Mich. Agr. Exper. Station.

fore a rain, are more harmful than when used during a drouth. It would seem that spraying soon after the foliage puts out is less harmful than when it is delayed a few days, or better a few weeks. London purple may be used on apple, plum, cherry, pear and most ornamental trees, but on these it should never be stronger than one pound to two hundred gallons of water. If the arsenites are to be used on the peach to defend against the curculio, Paris green only should be used, and that not stronger than one pound to three hundred gallons of water. The injury done to the foliage is never immediately apparent."

Prof. Bailey, of the Cornell Station, summarizes his recent experiments as follows:* "Peach trees are very susceptible to injury from arsenical sprays. London purple is much more harmful to peach trees than Paris green, and it should never be used upon them in any manner. Injury is much more liable to occur upon full grown foliage and hardened shoots than upon young foliage and soft shoots. The immunity of the young growth is due to its waxy covering. Injury late in the season is more apparent than early in the season because of the cessation of growth. Injury from the use of London purple may be permanent and irreparable. The length of time which the poison has been mixed appears to exercise no influence. London purple contains much soluble arsenic (in our sample, nearly 40 per cent), and this arsenic is the cause of the injury to peach foliage. A coarse spray appears to be more injurious than a fine one. A rain following the application does not appear to augment the injury. Meteorological conditions do not appear to influence results. Spraying the peach with water in a bright and hot day does not scorch the foliage. Paris green in a *fine spray*, at the rate of one pound to three hundred gallons of water, did not injure the trees. Probably one pound to three hundred and fifty gallons of water is always safe."

Finally, Prof. Gillette, of the Iowa Station, has taken up the subject in a very careful manner, and comes to the following conclusions, which he considers well proven†: "The oldest

*Bulletin 18, Cornell Agr. Exper. Station.
†Bulletin 10, Iowa Agr. Exper. Station.

leaves are most susceptible to injury from arsenical applications. They often turn yellow and drop without showing the burnt spotted appearance. Dews, and probably direct sunlight, increase the injuries done by the arsenites to foliage. Leaves kept perfectly dry can hardly be injured by the arsenites, even when they are applied very abundantly. The only effect of a heavy rain or dashing shower following an application of one of the arsenites is to lessen the injury to foliage. When freshly mixed and applied, London purple is most and arsenic is least injurious to foliage. White arsenic in solution should not be used upon foliage without first adding lime, Bordeaux mixture or some other substance to prevent its injurious effects upon foliage. White arsenic, if allowed to stand many days in water before being applied, will do far greater harm to foliage than if applied as soon as mixed. Lime added to London purple or Paris green in water greatly lessens the injury that these poisons would otherwise do to foliage. Lime added to a mixture of white arsenic in water will greatly increase the injury that this poison would otherwise do to foliage. If the arsenic is all in solution, the lime will then lessen the injury, as in the case of London purple or Paris green. London purple (Paris green and white arsenic have not yet been tried) can be used at least eight or ten times as strong without injury to foliage if applied in common Bordeaux mixture instead of water. The arsenites cannot by any ordinary method be successfully mixed in a kerosene emulsion. London purple in sulphate of copper solution does vastly more harm than when applied in water only."

Conclusions which he put forth tentatively, are: "Applications made in the heat of the day and in the bright sunlight do not injure foliage more than when applied in the cool of the day. Leaves suffering from a fungous disease are more susceptible to injury than are healthy leaves. The arsenites mix readily in resin compounds and do not seem to be more injurious to foliage than as ordinarily applied in water. The arsenites in strong soapy mixtures do considerable more harm to foliage than when applied in water only. The arsenites mix

readily in carbonate of copper solution and do not seem to do more harm than when applied in water only."

Beside what appeared in Bulletin 14 of this Station the above is practically all that is known concerning the effects of the poison on the foliage, and though the past season has seen a very great advance in our knowledge still there remains a wide field for research and questions of great immediate practical importance await solution. In the following pages we will present the results obtained by us, including those already published in Bulletin 14.

METHODS.

Something should be said as to the methods of experimentation to render the results more intelligible. At first it was intended to make experiments on a comparatively large scale, that is, the poison was applied to shrubs or trees of some size, or to measured areas of clover or grass, but after some trials this method was discontinued, both because of the difficulty of obtaining sufficient suitable plants for any extended series of experiments, and because of the difficulty of accurately estimating the amount of injury. Finally, it was decided to use single leaves to which the poison could be carefully applied and the leaves kept under close observation.

The amount of injury was estimated in tenths, that is, if about one-tenth of the leaf was destroyed, the injury was marked 1; if one-half of the leaf, 5; and so on. This was found to be very convenient both for estimating the damage and calculating the amount of injury in per cents.

To mark the experimental leaves a tag was at first attached to the stem, but later the more convenient plan of painting in small figures the number of the experiment on a conspicuous part of the leaf was used. This can be quickly done with a small brush and oil colors used by artists. No observable effect is produced on the leaf, and it will remain on the leaf a month.

The poison was applied in three ways. Jarred from a stiff brush a medium spray was very well simulated. For an even

thorough application the mixture was painted on the leaf with a soft brush. A third method, which was thorough and simple, was to dip the leaf in the mixture, which for that purpose was used in a shallow dish.

An extended series of experiments were made for the solution of each problem, to avoid the errors that the action of many unknown causes of variation might produce in the results if but a small number were depended upon. The larger the number of experiments the more reliance can be placed on the result. In reporting the experiments in this bulletin we have made it a rule to give the number of experiments, so that the reader can know the relative reliability of the various per cents given.

PROBLEM I.

What is the relative amount of injury to the plant produced by the different arsenites in use?

At the present time there seems to be but two arsenites in use, Paris green and London purple. White arsenic has been used more or less extensively in times past and has received high recommendations, but recently the injury it does to the foliage seems to have almost driven it from the list of insecticides. It was, however, thought worth while to give it a trial. There appeared such a great difference in the results obtained by the latter that it was found necessary to separate the results obtained from freshly made mixtures from those obtained when an old mixture was used. After the difference was noted a set of 352 grape leaves was experimented on, an equal number of which were treated with the different arsenites.

The results were one per cent of injury by fresh white arsenic, 84 per cent by white arsenic which had been mixed some time, 31 per cent by Paris green and 60 per cent by London purple. Below will be found a resume of all the experiments. They are not of course all parallel but it will be noticed that the

results are practically the same as in the experiments recorded above.

PLANT.	FRESH WHITE ARSENIC.		OLD WHITE ARSENIC.		PARIS GREEN.		LONDON PURPLE.	
	No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts	Per ct. of Injury.	No. of Expt's.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.
Apple	42	1	54	56	72	28	72	64
Peach	42	0	54	25	72	23	72	39
Sassafras	6	48	12	61	18	56	18	79
Cottonwood	.....	.....	18*	13	18	3	18	39
Grape	130	4	142	76	160	36	160	65
Total	220	4	280	58	340	22	340	56

* Had been mixed only about eight hours.

It is interesting at this point to compare the results with those obtained by Prof. Gillette. From table 1, page 404 l. c. we see the ratio to be London purple 24½, Paris green 19¾, and white arsenic 2¼, and from table 11 we see that old white arsenic gives 54¼ per cent. of injury. Of course none of these figures are of exactly parallel experiments, and so may not give the exact relationship between the poisons, still they agree with my experiments in the following conclusions:

1. Fresh white arsenic produces less injury than any of the other arsenites.

2. When not freshly mixed the injury produced by white arsenic is more than that of any of the other arsenites.

3. That Paris green is uniformly less injurious than London purple.

PROBLEM II.

What is the relation between the strength of the poison used and the injury produced?

In all the experiments made we found it necessary, in order to produce a readily observable effect upon the foliage, to use a much stronger solution than is used to kill insects. For most of the experiments the proportion used was one part by weight

of the poison to one hundred, one to two hundred and one to four hundred parts of water. To make white arsenic equal with the other arsenites, but one-half of the amount indicated in the table was used. The white arsenic by this method would be still a little the strongest, but it is approximately correct. In all the experiments reported in this bulletin the same method has been pursued.

A series of two hundred and forty experiments on oak gave the following results:

POISON USED.	1-100	1-200	1-400	1-600	1-800	1-1000
Fresh White Arsenic	32	25	7	3	6	2
Old White Arsenic	100	100	100	100	99	99
Paris Green	100	100	100	99	97	92
London Purple	93	91	80	34	44	25

A series of three hundred and twenty experiments on tomato give the following data:

POISON USED.	1-100	1-200	1-400	1-800	1-1600	1-3200	1-6400	1-12800
Fresh White Arsenic	0	0	0	0	0	0	0	0
Old White Arsenic	100*	100*	100*	100*	100	100	100	1
Paris Green	100*	100*	100*	100*	100*	100*	150*	3
London Purple	100*	100*	100*	100*	100*	3	1	0

*Stems also killed.

Below are the results obtained on a number of plants last spring.

Perhaps hardly enough experiments were tried in the case of the sassafras and cottonwood to insure accuracy, but they are given for what they are worth.

PLANT.	Strength of the Poison.	White Arsenic.		Paris Green.		London Purple.	
		No. of Exp'ts.	Per ct. of Injury.	No of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.
Apple	1-100	36	35	24	37	24	69
	1-200	30	35	24	26	24	62
	1-400	30	25	24	21	24	59
Grape	1-100	36	49	24	70	24	91
	1-200	30	31	24	44	24	79
	1-400	30	35	24	16	24	41
Peach	1-100	36	26	24	76	24	47
	1-200	30	44	24	37	24	33
	1-400	30	14	24	27	24	14
Sassafras	1-100	6	48	6	68	6	92
	1-200	6	80	6	60	6	70
	1-400	6	42	6	43	6	82
Cottonwood	1-100	3	33	3	17	3	57
	1-200	3	37	3	3	3	83
	1-400	3	7	3	0	3	20
	1-600	3	7	3	0	3	20
	1-800	3	0	3	0	3	50
	1-1000	3	0	3	0	3	3

These experiments are in all cases parallel and make the following conclusions quite evident:

1. The white arsenic is by no means as uniform in its action as the other arsenites, that is, the amount of injury seemed to depend less upon the strength used than was the case with the other arsenites.

2. Paris green is by far the most uniform in this respect.

PROBLEM III.

How much difference is due to the time of application?

To determine this point two hundred and sixteen applications were made on apple, grape and peach, care being taken to make the applications entirely parallel as to number, age of leaf, and method of application. The injury expressed in per cents is as follows:

POISON USED.	First Day.	Second Day.	Third Day.	Fourth Day.
White Arsenic	14	58	51	9
Paris Green	52	36	27	15
London Purple	67	60	58	30

These applications were all made during one month so that they probably show only the effects of the different atmospheric conditions. If these conditions can be made out we will have made a great step in advance. Fluctuations as great as these must occur in a time not longer than twenty-four hours judging from a large number of smaller sets of experiments which not being parallel are not worthy of publication. Prof. Gillette's experiments show the same thing. Compare for instance the results obtained June 24th and 25th.

The time of day that the application is made has long been supposed to have a great effect, but recent investigators have been unable to show any definite relation. Not that they do not find often a great difference between the effects of an application made in the forenoon and afternoon of the same day, but some days the application in the forenoon makes the most injury, and on other days the reverse is true. It seems very evident that the condition of the leaf, which is dependent upon the atmospheric condition at the time is the chief cause of this

variation. The fact that poison applied dry and kept dry can be applied in almost any quantity to a plant without injury would prove that the critical time is dependant upon the period of application and subsequent rains and dews. Leaves do not have the same power to absorb moisture at all times. A set of oak leaves was removed from the tree to test this matter and allowed slowly to dry, and from time to time their absorptive power was tested. At first this power increascd, and then it steadily diminished. Other leaves were removed from the tree from time to time during the day and tested in the same way. Exactly the same result was produced, but it took longer time. Thus, leaves removed at seven got in the condition in which they could absorb the most water by 9 o'clock, while those on the tree did not get to this condition till eleven. With the conditions of the leaves the day of this trial, an application made about eleven o'clock would probably produce the most injury, and late in the afternoon the least. Under other conditions it is conceivable that the time when the greatest injury might be produced could be in the afternoon or at any time of the day. This will explain why experimenters have not been able to reach definite results as the best time of day to make the applications of the arsenites. We have some evidence, that by the use of the wet bulb thermometer, one may be enabled to avoid the times when the application is attended with the most risk. It will take another season's experimentation before we can make positive statements and give practical directions.

Not only is there variation due to external condition but there is also a marked seasonal variation, probably due to the maturity and other physiological conditions of the plant. Prof. Bailey noticed this to some extent on the peach, and attributes the immunity of the young growth to a waxy covering. Be this as it may, there seems to be a regular increase in the susceptibility to the injury of the arsenites until a date not exactly determined in the summer, and from that on, a regular decrease. This seasonal variation may make it advisable to use different strengths at different times.

PROBLEM IV.

How much difference is there in the action of the poison on different plants?

In the tables above, the effect of the arsenites on the different plants may be seen. The experiments there reported are not, however, all parallel, so a set was selected that would not have this objection. It consisted of 240 experiments each upon apple, peach and grape. These represented different conditions, methods of application and all the arsenites, but were entirely parallel. The per cent. of injury was found to be: apple 39 per cent., peach 25 per cent. and grape 51 per cent.

A word of explanation should be made about the peach. There is a secondary effect produced upon the older leaves, an abnormal ripening of the leaf, causing it to turn yellow and fall with all the appearances that are normal late in the season. This secondary result does not begin to be produced for a week or ten days, and is not included in the figures given above. If it were included, the per cent. for peach would be much higher and increase as the leaves become older. This explanation should apply to all the peach experiments recorded in this bulletin. We intend, in a subsequent bulletin, to give experiments showing the relative effects of the arsenites as shown by this secondary effect.

Prof. Bailey's experience was, that the peach was peculiarly susceptible to the injury, but Prof. Gillette's experiments show quite similar results to mine. His experiments were not parallel, but taking an average of them all, we have plum 29 per cent., apple 21 per cent., cherry 18 per cent., alder 1 per cent. and peach 26 per cent.

As a rule the arsenites maintain the same order as regards the amount of injury that is with fresh white arsenic, giving the least injury followed by Paris Green, London Purple and old white arsenic. On oak and tomato, as reported above, the Paris Green is much more injurious than London Purple. It appears that for the best results a different formula, both as to kind and amount of poison used should be used.

PROBLEM V.

How much variation is there in the action of the poison on the different varieties of the same plant?

To solve this problem, forty-four varieties of grapes were used. Eight leaves of each variety were selected, two were treated with fresh white arsenic mixture, two with an old mixture of the same, two with Paris Green and two with London Purple. Below we have arranged the varieties in the order of greatest injury, and indicated the class to which they belong.

Varieties Showing More Than the Average Amount of Injury.			Varieties Showing Less Than the Average Amount of Injury.		
VARIETY.	Per ct. of Injury.	CLASS.	VARIETY.	Per ct. of Injury.	CLASS.
Wilder	75	Hybrid.	Rogers' No. 11	44	Hybrid.
Munson's No. 25	71	"	Munson' No. 45	44	"
Hayes	66	Labrusca.	Munson's No. 26	44	"
Naomi	64	Hybrid.	Cornucopia	41	"
Munson's No. 50	63	"	Early Victor	41	Labrusca.
Norton's Virginia	61	Æstivalis.	Triumph	40	Hybrid.
Rogers' No. 5	60	Hybrid.	Munson's No. 27	40	"
Mission	57	Vinifera.	Munson's No. 41	38	"
Beauty	57	Labrusca.	Pearl	37	Riparia.
Centennial	56	Æstivalis.	Eumelan	35	Æstivalis.
Concord	55	Labrusca.	Berckman's	34	Hybrid.
Rogers' No. 36	55	Hybrid.	Ulster Prolific	34	Labrusca.
Rochester	55	Labrusca.	Flowers	32	Vulpina.
Missouri Riesling	52	Riparia.	Anida	32	Labrusca.
Rogers' No. 13	52	Hybrid.	Munson's No. 67	32	Hybrid.
Hartford	51	Labrusca.	Rogers' No. 8	31	"
Jessica	51	Hybrid.	Cynthiana	30	Æstivalis.
Vergennes	50	Labrusca.	Munson's No. 38	29	Hybrid.
Rogers' No. 14	47	Hybrid.	Munson's No. 71	27	"
Rogers' No. 2	45	"	Rebecca	23	Labrusca.
Marion	45	Riparia.	Zinfandel	22	Vinifera.
			Scuppernong	16	Vulpina.
			Thomas	15	"

To show the relation of the different classes, we have summarized the experiments in the following table:

CLASS.	No. Varieties.	Maximum Injury.	Minimum Injury.	Average Injury.
Hybrids	22	75%	27%	46%
Labrusca	10	66	23	46
Æstivalis	4	61	30	45
Riparia	3	52	37	39
Vinifera	2	57	22	39
Vulpina	3	32	15	24
Total	44	75	15	44

CONCLUSIONS.—1. A greater amount of variation is found among the varieties than between the different plants.

2. This variability is almost wholly of the varieties, as practically the same amount of injury is sustained by each class.

3. The Vulpina class is probably an exception to this rule, suffering a very small amount of injury. The small number of varieties represented, however, would prevent a positive statement.

PROBLEM VI.

What effect has the age of the leaf upon the amount of injury sustained?

It is quite commonly believed that young, tender foliage is more injured by the poison than the older, firmer leaves. Our experiments give very positive evidence against this view, and support the observations of Profs. Cook and Bailey. Below are the data.

PLANT.	Age of Leaf.	WHITE ARSENIC.		PARIS GREEN.		LONDON PURPLE.		TOTAL.	
		No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.
Apple	Old	48	35	36	33	36	68	120	44
	Young	48	29	36	23	36	60	120	36
Grape	Old	48	39	36	43	36	71	120	50
	Young	48	39	36	43	36	70	120	50
Sassafras	Old	9	70	9	77	9	83	27	76
	Young	9	43	9	33	9	80	27	51
Peach	Old	48	27	36	32	36	37	120	31
	Young	48	14	36	15	36	26	120	18
Total	Old	153	34	117	39	117	61	387	44
	Young	153	27	117	27	117	54	387	34

CONCLUSIONS.—From the above table it will be seen:

1. That without exception the old leaves suffered as much as the young.

2. That, excepting the grape, the young leaves suffered much less than the old leaves.

PROBLEM VII.

Do the different sides of the leaf differ in susceptibility to the effects of the poison?

For these experiments the leaves were carefully painted with the mixtures. The leaf was laid flat in the hand and a full brush drawn across. Care was taken to wet the whole surface and only the side intended.

PLANT.	Side of Leaf.	White Arsenic.		Paris Green.		London Purple.		Total.	
		No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.	No. of Exp'ts.	Per ct. of Injury.
Apple	Both	32	44	24	37	24	77	80	52
	Upper	32	18	24	12	24	36	80	22
	Lower	32	34	24	34	24	79	80	47
Grape	Both	32	49	24	53	24	79	80	59
	Upper	32	34	24	29	24	59	80	40
	Lower	32	33	24	48	24	74	80	50
Sassafras	Both	6	87	6	72	6	100	18	86
	Upper	6	22	6	39	6	37	18	33
	Lower	6	62	6	62	6	93	18	72
Peach	Both	32	19	24	20	24	34	80	24
	Upper	32	19	24	30	24	30	80	26
	Lower	32	24	24	20	24	30	80	25
Cottonwood	Both	6	20	6	3	6	57	18	27
	Upper	6	10	6	3	6	25	18	13
	Lower	6	8	6	3	6	35	18	15
Total	Both	108	42	84	37	84	65	276	48
	Upper	108	23	84	24	84	41	276	29
	Lower	108	31	84	34	84	61	276	41

CONCLUSIONS.—The results obtained are very uniform except in the case of the peach and cottonwood where they are most discordant. We notice:

1. In the case of the apple, grape and sassafras that the lower side of the leaf is much more susceptible to the injurious effects of the poison than the upper side.

2. Except in the case of the peach an application to both sides is more injurious than to either side alone but not as injurious as the sum of the application to the two sides.

3. The peach presents a curious anomaly in respect to the action of the poison on the different sides.

PROBLEM VIII.

What relation do the earlier effects of the poison injuries sustain to the ultimate effects?

We made 352 experiments on grape leaves that were observed two days after the application of the poisons and again after eight days. The results are presented in the table below. The column headed ratio of readings shows the per cent of the whole injury that was observable after two days.

POISON USED.	RATIO OF READINGS.	ULTIMATE INJURY.
Fresh White Arsenic	.50	1 per cent.
Old White Arsenic	.61	84 "
Paris Green	.42	31 "
London Purple	.58	60 "

Another set of only 54 experiments on grape leaves produced similar results.

POISON USED.	RATIO OF READINGS.	ULTIMATE INJURY.
White Arsenic	.63	44 per cent.
Paris Green	.20	27 "
London Purple	.41	40 "

In a set of 54 experiments on grape leaves one-half of the leaves were old and the other half young. Only 22 per cent of the ultimate injury was observable in two days on the old leaves while the young showed 61 per cent.

Eighteen to which the poison was applied to both sides showed in two days 47 per cent of the ultimate injury. The

same number painted with the poison only on the upper side showed in that time only 26 per cent, while when applied below alone 41 per cent was to be seen.

CONCLUSIONS.—The amount of ultimate injury in the case of the fresh white arsenic was so small that we will disregard it. From the other data we obtain important conclusions:

1. The injury from white arsenic is seen comparatively very soon after it is applied. London purple is almost as active.

2. Paris green does its injury much more slowly.

3. Young leaves are affected much more quickly than are the old ones.

4. Applications to the lower side of a leaf produce injury more quickly than if the poison is applied above.

5. Except in the case of young leaves, it seems to be the rule that where the greatest injury is produced, a greater proportion is early apparent.

There are certain conclusions of practical importance that deserve to be emphasized.

Where the plant is easily injured, and the choice is between Paris green and London purple, *Paris green is better in every particular.*

Spraying with the arsenites has become a recognized part of the culture of some plants. With such plants *varieties could be produced by selection, to which strong poisoning would do no injury.*

When as is often the case it would be as effectual, it should be remembered that *a light spraying from above is the safest.*

Plants can be sprayed with equal or more safety when the leaves are young than later in the season.

Freshly mixed white arsenic promises to be one of the very best of the arsenites and at the same time the cheapest. It has, however, some very serious objections, which we are now attempting to overcome. Our work in this line will be reported in a subsequent bulletin.

C. W. WOODWORTH.

VETERINARIAN'S REPORT.

LETTER OF TRANSMITTAL TO DIRECTOR.

Sir:—I herewith hand you a report of progress of the work on which I have been engaged during the year. Acting upon your advice, I have devoted my time mainly to investigations of Texas or Southern Cattle Fever which, in this and other Southern States, is the most necessary work devolving upon the veterinary pathologist. Unfortunately, few of the experimental stations of the south have recognized the need there is for work in this field, and consequently, the results which have hitherto been obtained lack that confirmatory evidence which is quite essential in this new line of research.

The experiments directed by the Missouri veterinary department, and in which we assisted, have led to some important results, certain points being thus established which previously were either unknown or only conjectured. Some of these will be brought out in this report.

The efforts to produce immunity against Texas fever by inoculation—the first ever undertaken—seem to show that something may in the future be done in this line, but they also show the necessity of placing the etiology of this disease on a surer footing.

Most of my time during the summer was devoted to the task of establishing whether or not southern cattle carry in their *systems* the germs (bacterial) of Texas fever. The results of this and later work, so far as completed, are contained in my report.

Respectfully,

R. R. DINWIDDIE.

SOUTHERN CATTLE PLAGUE, (Texas Fever.)

Seeing that this disease has its home in all the southern States, and probably existed in these as early as in Texas, the name of Southern Cattle Plague, suggested by F. S. Billings, seems more appropriate than that of Texas Fever. However, it has not been generally adopted so far, and in this report these terms are used indiscriminately.

Before entering on a report of the work on which I have been engaged during the past year, I shall briefly refer to the results obtained from the experiments in which we were conjoined with the Missouri Experimental station during the previous year, and which were mentioned in my last report.

The principal record of these experiments is contained in Bulletin 11, of the Missouri Agricultural College Experiment Station, written by Prof. Paul Paquin, and from this bulletin I shall extract what seems to me to be the most important and reliable of the results obtained. These have to do principally with practical points, some of which were either known or suspected before, but this knowledge rested only on general observation and not experimental proof.

As will be seen in this report, there are certain questions connected with the causation of the disease which still admit of doubt, some of the findings detailed in said bulletin being contradicted by the results of my work of the past summer. The possibility of preventing Southern Cattle Plague by inoculation must also, taking all the evidence into consideration, yet remain an open question.

As a result of these experiments, Dr. Paquin concluded that southern cattle contain the germs of this disease in their fæces and in their urine. He produced infection of pens by scattering the same over the surface of the ground and testing these pens later by placing in them northern cattle.

In one pen the animal died of Texas Fever; in the other it suffered from a mild attack.

He found that southern cattle ceased to be bearers of infection thirty days after removal from southern pastures, and that the

infective agent which they had deposited did not acquire its infective or virulent property before on an average thirty to fifty days after it had been dropped.

One experiment there recorded, however, shows a fatal result ensuing thirty days after the germs had been deposited by Texas cattle. Allowing an incubatory period of ten days, which is a minimum (In my experience I have never seen a death within fourteen days after exposure), this would leave only twenty days from the time the germs were dropped until they became capable of infecting northern cattle.

As it seems to me an important point to determine just how long the infection bearing mateial of southern cattle remains non-virulent, I give here some other data extracted from the same bulletin, in cases in which the northern cattle were exposed soon enough to allow of this period being computed.

In four instances northern cattle died from Texas Fever, or became sick from same disease after exposure to germs dropped from southern stock 30, 42, 49 and 51 days respectively. In all these instances, the northern stock were exposed within, at the most, nineteen days after the Texans had been first introduced into the same pens, and consequently before these pens presumably became capable of infection.

These are the only instances given in this report, or any other that I have seen, in which the conditions necessary for computing this non-virulent period of the germs are fulfilled. By deducting ten days of an incubatory period, we get the figures 20, 32, 39 and 41 as the number of days after the germs were deposited, until the time when they were shown to be virulent. They may, however, in the three last cases, have attained virulent properties in shorter time than the figures given since susceptible stock do not appear often to receive the infection on first exposure.

Billings, who collected statistics on this subject, found the average period when the disease appeared north after southern cattle had dropped the virus, to be about 55 days. (Bulletins 7, 8, 9, 10, Agricultural Experimental Station, Nebraska.)

As showing the influence of the sun's rays in affecting the occurrence of this disease, one experiment is recorded, in which a northern cow was placed in a pen along with a Texan just arrived. This pen was in shade, and presumably from this cause, the fatal result was postponed for fifty-five days. In three other infected pens which were shaded during part of the day, the northern cattle only showed slight signs of sickness.

On these questions, namely, the incubatory period of the disease, and the period of non-virulence of the excretions of southern cattle, Dr. Paquin, himself says:

"The period of incubation, *i. e.*, the lapse of time between the moment that germs are taken in the body by susceptible cattle and the appearance of the disease is between 8 and 12 days only."

"During favorable weather, virus spread in the north with fresh manure and urine directly from southern cattle, becomes virulent in about 30 days (and perhaps occasionally less), during the warm months, and remains virulent until decidedly cool weather."

These are some of the points which have been determined by these experiments, and on which the evidence seems to be reliable. There are many others on which conclusions are therein given, which I have not referred to because they require further confirmatory testimony before they can be accepted.

On the question of protection against Southern Cattle Plague by inoculation, I will give the results obtained in Arkansas in the cattle under my care, as well as those obtained in Texas and Indian Territory, in the two latter cases taking as my authority the Annual Report of the Texas Agricultural Experiment station, 1889, and the before mentioned Bulletin of Missouri Experiment Station, No. 11.

Preventive Inoculation in Arkansas.—In order to test this method of conferring immunity against Southern Cattle Plague, the director of this Station, on my advice, accepted the terms proposed by the Missouri Veterinary Department, by which

cattle should be exchanged between the two states at mutual expense, those coming to Arkansas being inoculated according to the methods of Dr. Paquin, as at that time developed.

The fate of these imported cattle was given in the last Annual Report of this Station, without reference to the effect of these inoculations, as that part of the experiments was not at the time completed. The lacking details are supplied here.

July 9th, the first shipment, consisting of eight 1 and 2 year old cattle, arrived from Missouri and were placed in an infected pasture at Helena, Ark.

The following table gives in readiest form the results obtained:

No. 1, not inoculated, died July 25th.
No. 2, not inoculated, died July 29th.
No. 3, not inoculated, died July 30th.
No. 4, not inoculated, died July 31st.
No. 5, inoculated, died July 28th.
No. 6, inoculated, died July 30th.
No. 7, inoculated, died July 28th.
No. 8, inoculated, did not contract fever

Percentage which contracted fever:
Inoculated stock, 75.
Not inoculated stock, 100.

This result was not encouraging, but so far as the figures go, it did seem to indicate a slight protective influence in the inoculations as practiced. Accordingly, when urgent request was made from Missouri for a second shipment on similar terms, we decided to give the matter a further trial. The second lot of eleven arrived at Helena, August 13th and were placed on the same pasture as the first lot. One of these died during shipment. On being opened it showed some of the post-mortem appearances of Southern Cattle Plague, especially observable in the enlarged, congested spleen and discolored urine. My opinion is, that this animal died from the disease in question, either from inoculation or from some accidental exposure of which we have no evidence. Omitting this animal from the

reckoning, there were of this lot, six inoculated and four not inoculated. From information supplied at the time of the shipment, I learn that of these six, four had been inoculated twice, on the 2nd and 9th of August, respectively, before shipping. Two had received one inoculation in Missouri on August 9th, and these two were re-inoculated on the day following their arrival at Helena, August 14th, with material supplied by Dr. Paquin. I injected the fluid beneath the skin of the neck in both instances. One steer, No. 6, received 25 minims. The following day there was a slight swelling at the place of inoculation, flat, hard and tender to the touch. Temperature was 101.5 F. This swelling had disappeared by the 20th. The temperature did not rise above the normal.

No. 7, a two year old heifer, received on same date 30 minims of fluid in glass tube specified. This inoculation did not produce any observable swelling nor impairment of health.

The virus used in all the inoculations of these cattle, appears, from the information supplied, and from records of same in Bulletin 11, of Missouri Station, to have been cultures in beef infusion of germs obtained from the organs or excretions of southern cattle, from ticks on the same, or from northern fever stricken cattle.

The fate of this second lot of cattle can be tabulated as before:

No. 1, inoculated, did not contract fever.
No. 2, inoculated, dead on arrival at Helena, August 13th.
No. 3, inoculated, died August 30th.
No. 4, inoculated, died August 31st.
No. 5, inoculated, did not contract fever.
No. 6, inoculated, did not contract fever.
No. 7, inoculated, died August 31st.
No. 8, not inoculated, died August 27th.
No. 9, not inoculated, showed fever August 28th, recovered.
No. 10, not inoculated, showed fever August 28th, recovered.
No. 11, not inoculated, died September 1st.

In the second shipment, therefore, there contracted fever:
Inoculated cattle 50 per cent.
Not inoculated cattle, 100 per cent.

For the whole experiment the figures bearing upon the protective influence of these inoculations are: Of ten inoculated cattle six contracted fever, or 60 per cent; of eight cattle not inoculated eight contracted fever, or 100 per cent, or, taking the deaths as the basis of comparison, we have (since two non-inoculated cattle contracted the disease and recovered), deaths among inoculated stock 60 per cent; deaths among non-inoculated stock 75 per cent.

This is the result obtained from these efforts in Arkansas. At Texas Agricultural Experiment Station the results seem to have been more favorable. These are recorded by Dr. Francis in the Second Annual Report of that Station as follows: First shipment of twelve head from Missouri arrived in Texas June 28, 1889. Result: Five of six not vaccinated died, 83.3 per cent; three of six vaccinated died, 50 per cent.

A second lot of fourteen head arrived in Texas September 13, 1889. (Two of these died shortly after arrival, from other causes, and are not reckoned.) Result:—Three of four not inoculated died, 75 per cent; two of eight inoculated died, 25 per cent.

Further tests were made in Texas and Indian Territory, and at the Kansas City stockyards.

At the stockyards the result of exposing cattle in infected pens was: Of six vaccinated, one contracted the disease; of three un-vaccinated, all became affected and one died.

A shipment of forty head all inoculated was made December 1, 1889, to infective ground in Indian Territory where the average percentage of deaths in unprotected, imported northern stock is given at over 50 per cent.

The latest record of these furnished is March 12th, when one had died of the fever.

Another shipment of sixty-four head inoculated cattle to a private individual in Texas proved unfortunate, owing, it is said, to the use of too strong virus.

Still another to San Angelo, Texas, of thirty cattle December 24, 1889, is recorded, in which all were in health up to the middle of April, 1890.

Such is the record of these attempts at preventive inoculation published up to date of this writing. Judgment on the question must be suspended until we hear how these last inoculated cattle in Indian Territory and Texas have withstood the summer following their arrival.

If it can be conclusively shown that these inoculations have had any protective influence, this knowledge, apart from its practical application, would have an important bearing on our conception of the nature and etiology of the disease, affording proof that the germs of Southern cattle plague can be cultivated, and the disease artificially produced by the cultures obtained, in other words, that we have here in all probability a bacterial disease like authrax or swine plague. That Texas Fever is of this nature has been asserted by Detmers, Billings and Paquin who have each found a bacterial organism which they associated with it in a causative relation. The discrepancies in their descriptions, however, show that they were dealing with different organisms, and therefore the proof that any of their germs is the real cause of the disease is yet lacking.

Bacterial Studies on the Organs of Southern Cattle.

During the past summer I have made bacterial studies on the internal organs of cattle raised on territory infected with the germs of Southern Cattle Plague, with a view of testing the question whether or not these contain any bacterial organism, as has been frequently asserted. If such cattle do contain constantly in blood, bile and viscera any one organism and that one alone, then we have good grounds for considering this the much sought for germ of Texas Fever. In the intestinal contents bacteria are constantly present but bacteriologists now admit that the healthy living animal does not regularly bear in its tissues or organs any living germs.

In investigating this point is is necessary that the animals

which are the objects of study be raised on infected soil and that they be free from any other disease bacterial or otherwise. Both of these points were secured in my work which was carried on at Little Rock, a part of the State which is surrounded by infected territory. Cattle shipped there from the north die of Southern Cattle Plague to the extent of at least 60 per cent.

The specimens were obtained from cattle killed for beef at the slaughter pens, and were apparently in excellent health.

In this article I can not enlarge on the technicalities of practical bacteriology but will only give sufficient details to enable the reader, lay and professional, to estimate my work at its just value.

In order to determine the presence of bacteria in organs or in fluids of the animal body two methods are employed and these must be used in conjunction; these are microscopic examination and inoculation of culture media in test tubes. Unless by one or other of these methods we can demonstrate the presence of bacteria we are not justified in assuming that they are present. Both methods in this instance yielded negative results and hence I am forced to conclusions at variance with others who have found germs in this situation.

The culture media employed were beef-infusion-peptone, nutrient agar, glycerin agar, cooked potato and milk.

Inoculations were made from blood, bile, liver and spleen, and in a few instances also from the kidney.

The inoculations were made in all cases within half an hour after death in respect to some of the tubes in each series, namely, those used at the slaughter house; others were inoculated generally within two or three hours after death, in the laboratory. In such cases the specimens were wrapped in cloths saturated in sublimate solution (1-1000) until used. Blood and bile were conveyed to the laboratory in sterile vials or vacuum pipettes.

In all, I made in this manner eight series of tests from healthy southern cattle. In each series a large number of tubes were used, generally from forty to sixty. By this means we diminish the risk of forming false conclusions owing to the pres-

ence of germs introduced as contaminations. A certain number of the tubes in each series were placed in the thermostadt kept at about 35° C., the remainder kept at room temperature. It may be well for me to state here my views on what constitutes reliable grounds for deciding whether or not the growths we may get on our tubes really come from the source we inoculate from

If, for instance, germs be present in the liver of a southern steer, inoculations by means of the platinum wire to ten tubes of beef infusion (provided the germs are capable of growing on this soil), ought to give rise to growths in all or nearly all ten tubes, if they are kept under the same conditions. If only one growth be present out of the ten tubes we must regard that as an accidental contamination during the process of inoculation or subsequently. If several growths be obtained, which by naked eye or microscopical examination are seen to differ from each other we can not affirm that any of these were obtained from the source in question, and such tubes would yield no basis for any reliable conclusions.

In this work, especially when performed at a slaughter house, contamination of tubes is very liable to occur even with the most skillful manipulation, and such was the case in my work. I found that in tubes inoculated at the slaughter pens generally about ten per cent yielded growths, these being especially tubes of liquid media.

The growths thus obtained were not of the same species in many cases and were always regarded as contaminations. Tubes inoculated in the laboratory were much less frequently contaminated, although even here, on account of dust, bacterial work was attended with difficulties. The first series of inoculations yielded a growth on over seventy-five per cent of tubes inoculated from the liver, these growths being nearly all composed of the same organism. Part of these tubes were inoculated in the slaughter house and part in the laboratory, and there is no doubt in my mind that the germs obtained were present in the liver. This germ is a refrangent coccus or round body some-

times found in chains of four or more elements but oftener in pairs. It grows readily at summer temperature on all culture media employed, perhaps most slowly on glycerin-agar and potato. The growth on agar is pure white, smooth and glistening; it does not spread over the surface but is raised and limited laterally. In beef infusion it clouds the fluid rapidly, forming, if not disturbed, flakes which extend in parallel streaks from the surface downwards; no surface pellicle is formed but a large whitish sediment soon collects at the bottom of the tube.

The growth on gelatin is peculiar; it spreads from the stab through the medium which it renders opaque but leaves still in a semi-solid form.

This micro-coccus was present in the liver of one animal only and in no other organ. Cultures from the bile of this animal gave a mixed growth of bacilli and cocci.

The spleen, kidney and blood gave no growth.

Without detailing the result of each series of inoculations I may say in brief that not in one of the animals on which bacterial studies were made was there evidence of the presence of any bacterial organism except in the one which I have mentioned above, and in that one it was only present in the liver.

Microscopic examination of fresh specimens from these animals gave the same result. Neither in the blood nor in smear cover glass preparations from the liver or spleen could bacteria be demonstrated. There is an appearance of the blood, however, which I have often observed when examining such preparations, and which, I think, has misled some investigators. When blood from one of these animals was examined an hour or two after death, sometimes the red blood cells were found distorted as if the protoplasm of the cell had separated into little masses near the margin. The outline of the cell at the same time had lost its rounded form and become irregularly crenated or spiny. These masses have a rounded or ovoid form and very much resemble bacteria. It is, however, merely a phenomenon which may be observed in all blood, the density of which has been altered by evaporation.

One other point I will mention here in connection with the microscopic examination of the bile. In most fatal cases of Southern Cattle Plague, the bile contained in the gall bladder is thick from the presence of yellow mucus flakes; if the fluid portion is tested for albumen by means of nitric acid it yields an abundant coagulum. If a drop of this bile, taken from the bottom of a vial be examined under a magnification of two hundred diameters or more, there is seen amidst this yellow, unorganized debris, peculiar rod-shaped forms, highly refractive and of a deep bronze color. (Fig. 1.) These vary considerably in size, and also to some extent in shape, many of the smaller forms looking very much like bacilli. I have seldom failed to see them in the bile of Texas fever, especially after this bile had been kept in a vial or sterilized pipette for some days, but they are also often present immediately after death.

These bodies, although they often show curved outlines bearing little resemblance to crystals are, nevertheless, of a crystalloid nature. They resist the action of acids, chloroform and ether, but are at once dissolved by a solution of caustic potash.

I have found the same equally abundant in the bile of animals slaughtered for beef whose livers were more or less diseased from the presence of the liver fluke. They, therefore, are not characteristic of Texas fever. It is evident from these negative results that we must seek for the germ of Southern Cattle Plague elsewhere than in the fluids and tissues of healthy southern cattle.

CAN THE GERM BE CULTIVATED FROM DISEASED CATTLE?

On this question we have the authority of F. S. Billings, who found his germ—an oval or short bacillus—in the blood or organs of northern cattle dying from Southern Cattle Plague in Nebraska. He succeeded in demonstrating it (to his own satisfaction) in sections of hardened organs and in cover glass smears, and found it capable of ready cultivation on all the usual media.

Paquin also has had positive results in his attempts to cultivate the germ from this source, but we have no sufficient evidence that he and Billings were dealing with the same organism.

During the summer of 1889, from pressure of other work, bacterial studies were not attempted on those cattle from the north which died at Helena, and this summer I have had little opportunity of making such studies on diseased cattle from the lack of suitable cases.

During the heat of summer, a subject, to be suitable for this purpose must be opened within one or two hours at most after death.

I have had the opportunity, since commencing this line of work on Southern Cattle Plague, of examining only three cases of that disease in which the post-mortem examination was held sufficiently early to allow of culture tests being made. Two of these were unsatisfactory, but the third afforded all the opportunities desired.

Case No. 1, a Jersey cow, died July 7th, about 11:30 a. m., at Little Rock, and was examined at 4 p. m. In this and the following case I was assisted in the post-mortem examination by Mr. A. E. James, veterinarian of Little Rock, who had the animals under his treatment, and recognized the symptoms as those of Southern Cattle Plague. After satisfying myself that this disease was the cause of death, I made a number of tube inoculation in the field and obtained material for use at the laboratory. Only a small number of tubes were used, as I considered that decomposition bacteria would certainly be present; the result showed that this was the case. I obtained a strepto-coccus from the blood and mixed cultures from the liver. *All tubes inoculated from the spleen remained sterile.*

The second case occurred at the same place, July 10th, at noon. It was examined as early as possible, which, however, was not until 4 p. m.

A large number of tubes were used in this instance. The results, as in the previous case, were disappointing, mixed cultures of putrifactive germs being obtained in all the tubes *except those inoculated from the spleen*, which were sterile.

The liver of a fœtus which was contained in the womb also proved sterile. Evidently putrifactive germs had not yet penetrated to these parts.

The spleen, in neither of these cases contained germs capable of growth. I infer from this that after death it is perhaps one of the last organs to be invaded by septic bacteria. In both cases it was much enlarged and softened.

The third case was a Hereford cow belonging to the college farm which had contracted the disease during a sojourn of two weeks in infected territory. It was fed during that time on hay and grain and did not at any time have an opportunity of grazing on the pastures there. It was watered at a branch along with many others native to the district, and this may have been the source of infection. At the time of death no ticks were found on the body. The cow died November 16th, at 4:30 p. m., and it was opened at once and material conveyed to the laboratory for examination and culture tests. A large number of tubes of the various media were sown with the juice from the liver, spleen and kidney, as well as the bile, urine and blood of this animal. Kept in the thermostadt at 35° C., and at room temperature these tubes generally remained sterile. More particularly, out of forty-five used thirty-nine remained sterile, the others yielded growths which were apparently contaminations. Three of these growths were in tubes inoculated from the urine which may have been exposed during collection. They consisted of micro-cocci or round forms. The other growths, in beef infusion, were from the liver and bile, and were putrifactive bacilli.

From fatal cases of Southern Cattle Plague, or rather from this one case, and the spleen of two others, I have therefore obtained the same negative result as from healthy southern cattle. I do not, on the strength of these insufficient tests, pretend to absolutely refute the claims of those other investigators who have found an organism in the organs of cattle dying from this disease, which they could readily cultivate, but I am inclined to look on them with doubt. One case does not seem

much to base conclusion upon but if there is a germ in Southern Cattle Plague which becomes generalized and is readily cultivated, then this germ should be present in all cases and should have been obtained by such methods as I employed.

MICROSCOPIC EXAMINATION OF FRESH MATERIAL.

Spleen pulp examined fresh in thin layer showed besides blood and splenic corpuscles numerous small globular bodies between these cells. They vary very considerably in size, from perhaps one-eighth to a fourth the diameter of the red corpuscle while in many of these corpuscles themselves small clear spots could be readily detected.*

Juice from the kidney showed the same appearances in a much higher degree. Here these bodies were much more numerous both in and between the corpuscles. Cover glass preparations stained one hour in warmed Gentian violet solution and sufficiently decolorized show these objects very distinctly. In the kidney of this case nearly all the red corpuscles showed within their substance, when thus stained, one or two, rarely three or four, small dark bodies, but apparently the same objects were seen even more numerous outside of the corpuscles. What the significance of these bodies is I am unable to say, but I can confirm Dr. Smith's assertion of their presence, not confined however to the interior of the blood corpuscles as he asserts. It is possible that this appearance is the result of rapid degeneration of the corpuscles. At any rate I have seen, on making comparative examination of smears from the spleen of healthy cattle, similar bodies here and there within the red corpuscles. I could detect no difference between the latter and those seen in this case of Texas Fever, except in their very much smaller number, and the fact that the spleen is an organ in which the red corpuscles largely undergo destruction tends to strengthen this explanation of the abnormal conditions referred to.

*NOTE.—These intra-corpuscular bodies were first described by Dr. Theobold Smith, of the Bureau of Animal Industry, who regards them as parasites and the causative agent in Texas Fever.

EFFORTS TO PRODUCE THE DISEASE EXPERIMENTALLY.

In the study of this plague one of the first questions which confronts us is whether or not it can be artificially produced. It is chiefly by experimenting in this direction that we can hope to understand the conditions essential to its occurrence in nature. Among other bacterial diseases of animals which have been investigated we have anthrax, black-quarter, glanders and chicken cholera, all of which can be experimentally produced by inoculation of material directly from a diseased animal to a healthy one.

Can the same be done in Southern Cattle Plague?

On this question we have the usual conflicting evidence. Observation of numerous outbreaks shows us that in nature this seldom or never occurs; northern diseased animals do not infect their neighbors.

The following tests seem to show pretty conclusively that it can not possibly occur in that way.

November 16, 1890, a calf aged ten months in good condition received an injection under the skin of the neck of 5 C.C. of dark colored urine obtained from a cow which died of Southern Cattle Plague the same evening. Temperature at time of inoculation 101.8° F. The calf was kept under observation and a daily record of its temperature made up till December 3d. A small painful tumor formed at the place of inoculation. This remained for over two weeks ultimately discharging a small quantity of matter. The appetite and general health did not at any time appear to be disturbed and the highest temperature recorded was 102.4° on the 26th. The result is therefore negative.

Spleen pulp. The enlarged and engorged spleen obtained from the above case of Southern Cattle Plague was kept over night in a cool place and the following morning 50 grams (about 1¾ oz.) of the semi-liquid pulp of the same, was bruised up in a mortar with about half a litre (1 pint) of water and after standing one hour was used as follows:

It was filtered through coarse cloth, and a small amount

further filtered through paper the latter being used for subcutaneous injection.

November 17th, a calf of eight months received under the skin of the inferior cervical region about 5 C.C. of this filtered fluid.

November 18th, another dose of the same amount and material was injected subcutaneously behind the arm.

Temperature at time of receiving the first dose 101.8°. F. Small enlargements formed at the places where inoculated, but up to December 3, during which time the calf was under observation, and temperature taken daily that was the only effect produced.

The temperature during that time ranged from 100.4°. to 102.5°. F.

November 17th, a yearling grade Hereford calf received as a drench, about a pint of the red fluid obtained from the above described treatment of spleen pulp in Southern Cattle Plague. The temperature at this time was 102°. F. Highest temperature during the next three weeks, 102.4° F. Average of daily records, 101.9° F.

The animals employed in these experiments were stock which had been raised on non-infected regions and therefore were susceptible of contracting the disease if it could be communicated in this way.

From these tests I infer that if the germs are present at all in the blood, spleen and urine in Southern Cattle Plague, they evidently do not find the conditions necessary for their further growth when transferred directly to our artificial culture media, or to the systems of healty, susceptible cattle. We may conclude (if further experiment should prove these results to be constant), either that the agent which induces the disease requires some period of development outside of the bovine organism, or that it is purely an intestinal parasite exerting its morbific influence by the absorption of the products of its growth.

Several attempts were made to produce the disease by the use of material obtained from southern cattle.

October 27th, calf of seven months received under the skin of the neck 1 c. c. of bile which had been obtained one month previously from a Little Rock steer and preserved in sterile sealed pipette.

The injection produced a slight local swelling which disappeared in four days.

The temperature did not rise above 102.6° F., and there was no sign of ill health following this injection.

November 1st, calf of the same age receceived subcutaneously in neck 4 c. c., of a three days old pure culture in beef-infusion of a micro-coccus obtained as described earlier in this report, from the liver of a Little Rock steer.

Kept under observation for seventeen days, the calf exhibited no ill effects nor rise in temperature.

This germ was also without effect on a guinea-pig inoculated at the same time.

IS THE GERM CONTAINED IN THE MANURE OF SOUTHERN CATTLE?

We know that southern cattle carry the germ of Southern Cattle Plague to the north in some manner, and it has been generally accepted that the principal medium in which the infection is deposited is the discharges from the bowels. No other theory so well explains infection of pastures in the north and along the railways over which such cattle have been shipped. In the way of experimental evidence however, there is but little advanced in favor of this theory.

Billings, it is true, found the bacterium which he regards as the cause of the disease, in fæces, both fresh and old of southern cattle, and found it fatal when injected into small experimental animals, but we have not sufficient evidence that he produced Southern Cattle Plague with germs from this source. The experiment of Paquin, recorded earlier in this report, bears more directly on the question, and, granting that there was no

accidental infection from the presence of southern cattle in the near vicinity seems to prove that both the urine and fæces bear the infectious principle. If this supposition be true, it ought to be capable of proof. I have been, and am now working on this line, but so far the desired result has not been attained.

The methods I have adopted to test this question have been:

1. By feeding the excrementitious matters directly to cattle mixed with ground feed.

2. By isolating the different species of bacteria found in the manure of southern cattle by means of gelatine plates, cultivating these separately and testing their effects on northern cattle and small experimental animals.

On making a culture from such material, we always get a mixed growth of various species of bacteria. (Fig. 2.)

By the use of plate cultures, I have succeeded in separating and growing in pure cultures eight different species. Some of these are evidently putrifactive germs which are everywhere present; others which appeared more promising, have been tested and found innocent when inoculated into cattle.

On making plate cultures from the contents of the ileum in the case of Southern Cattle Plague above referred to, I obtained colonies of one species only. This species consists of short baccilli, which were evidently present in very large numbers. The same species was obtained from the contents of the rectum of the same animal, here however, mixed with other varieties.

This bacillus in length is from about one-fourth to one-half the diameter of a colored blood corpuscle; grows readily in beef infusion at 35° C., rendering the fluid opaque and forming a considerable sediment in a few days. It does not seem to be capable of vital motion.

On gelatine plates (or Petri vessels), it forms beneath the surface round yellow colonies which grow slowly. On the surface they spread quickly in the form of a whitish film. There is no fluidifaction of the gelatine but after some days peculiar

branching crystal like forms make their appearance beneath this film or on its margin. On agar its growth presents nothing peculiar. It is rapid, dull white, smooth and spreading.

The action of this bacillus was tested on cattle by inoculation and continued daily feeding of cultures in beef infusion for a week in doses of 5 C.C.

On two calves which were subjected to this treatment no pathogenic action of the germ was exhibited. The same negative result was obtained from feeding the manure of southern cattle directly.

These tests afford no confirmatory evidence of the theory that the manure is the infection carrier, but it may well be objected; (1), that the manure was collected too late in the year, the last week of September, and (2), that it was not placed or kept under such conditions as occur when brought north by southern cattle, that is, deposited on the soil.

I have endeavored to fulfill these latter conditions as far as can be in laboratory experiments. Shallow boxes were filled with earth with a sod surface and on these was spread fresh and old manure collected in the south; also on one I placed a quantity of sod and surface soil and saturated it with branch water from the same infected regions. All were placed in the laboratory and kept as far as possible at a suitable temperature, generally over 70° F., and never as low as the freezing point. After two months (in Dec.), these were tested on yearling cattle by feeding. The grass (green and withered), roots and surface soil to the depth of one inch were cut up fine, mixed with ground food and given daily for a week, in one case. In the other the same material was soaked a sufficient time in water and given daily as drench.

Two cattle subjected to this treatment remained unaffected.

The object of these tests is of course to show if manure is the carrier of the infection. There is no practical question in the study of the disease more important than this, and it can only be determined by the experimental method. Another

question connected with this one is, if manure is the bearer of the Texas Fever germ is the intervention of the soil necessary to produce infection? So far as observation of such cases as naturally occur can inform us the answer would be that it is necessary.

Such observation shows us that the disease occurs in cattle (susceptible) which are, or have been grazing on soil permanently infected in the south, temporarily in the north. It also occurs in northern cattle which have been driven over the trails of southern cattle, where little opportunity has probably been allowed for grazing. Finally, it occurs in northern cattle which have been confined for even a short time in stockyards previously occupied by southern stock.

Although, in this last instance, there is no grazing, yet we still have the influence of the soil as a probable factor in producing infection, and I know of no cases on record in which this probability is entirely excluded.

CAN A STOCK CAR DIRECTLY INFECT CATTLE WITH SOUTHERN CATTLE PLAGUE?

I refer to this question because it seems to have acquired considerable importance from a legal point of view. No doubt there are many who will have no hesitation in answering it in the affirmative.

It is probably safest for the shipper of cattle to take this view of the question. At the same time I have to say that the proof that such is the case is not furnished by any records of outbreaks of the disease to which I have access, nor has it been furnished by experimentation.

That the railway companies are responsible for a large percentage of the cases of Southern Cattle Plague which occur in this State I have always affirmed. They are responsible in so far as their uncleaned stock cars in some manner infect the soil adjoining the railways, and from grazing on this ground cattle become infected.

That much does not admit of doubt, but to assert that stock cars can *directly* produce this infection is a step further than the

evidence justifies us in taking. This whole subject, namely, the infection bearing property of the manure, if it has any, and its direct or indirect mode of communicating Southern Cattle Plague to northern cattle, is well worthy of further experimental investigation.

There is no great difficulty in making practical tests of this kind except the opposition which is naturally manifested against the possible introduction of an infective disease into a previously uninfected district. This reason has prevented me hitherto from making any such tests during summer the season which is most suitable for them. It is not improbable that these feeding trials recorded above might have led to positive results if they had been engaged in during the summer months. It is hoped that, if the necessary facilities are afforded, similar and more extensive experiments of the same kind may be made next summer. In concluding this subject I may say that I have given my work and reasonings therefrom, somewhat in detail in order that others may form their own conclusions about it.

The evidence supplied in this report would seem to show: That southern cattle do not regularly carry in their blood, tissues or organs, any bacterial germ which can be cultivated or demonstrated by the usual methods employed in bacteriological investigations.

So far as our experience goes no germ can be cultivated from the same sources in cattle dying from Southern Cattle Plague.

Southern Cattle Plague can not be produced experimentally by inoculation or feeding to susceptible cattle material derived from the fluids or organs of the diseased, hence, probably, can not be communicated naturally from a diseased to a healthy animal.

To this may be added that our experiments, so far, afford no confirmatory evidence to the theory that manure from southern cattle is of itself capable of directly infecting northern stock.

OTHER ANIMAL DISEASES.

Black-quarter (Symptomatic Charbon) prevailed among the calves on the college farm during last spring. An attempt was made to test the method of securing protection by the use of sterile virus but owing to the disease spontaneously subsiding at that time no conclusions could be arrived at.

Glanders.—At the request of the owners I have examined and advised the destruction of a few cases of glanders during the year. This advice has in all cases been followed. Other cases supposed to be glanders I have heard complaint of, but have always abstained from making any examination except when requested to do so by the owners themselves. There seems to be a general impression, which I believe is well founded, that the disease is in most cases brought to the State by worthless ponies imported from Texas for sale here,

But little can be done in the suppression of glanders here, or in preventing its further introduction from without except by the intervention of proper laws dealing with the matter, laws which, at present, do not exist in this State.

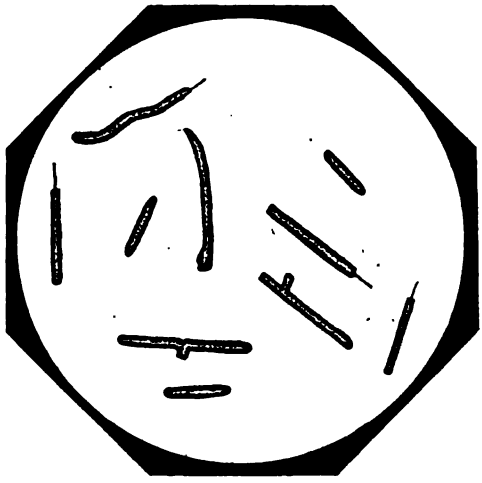


FIGURE 1.

Crystals from the bile in Southern Cattle Plague (Texas Fever). X1020.

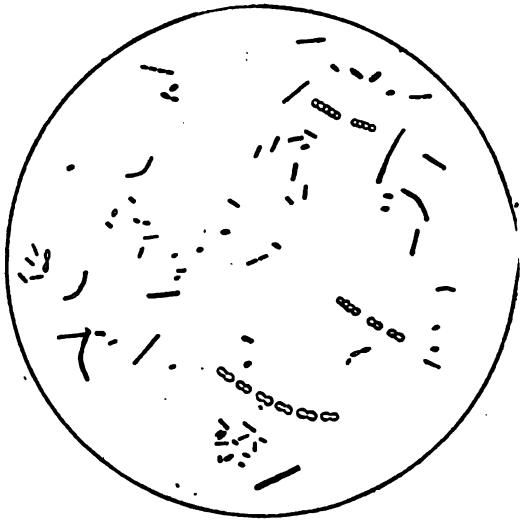


FIGURE 2.

Mixed Culture in Beef Infusion from Manure of a Southern Steer. X510.

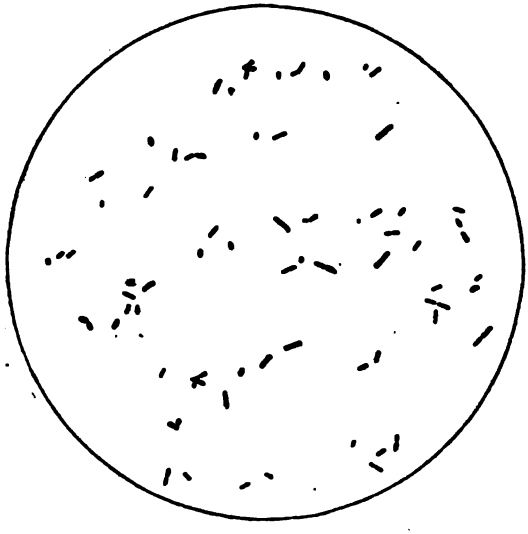


FIGURE 3.

Bacilli from Contents of the Ileum in a Case of Texas Fever. X510.

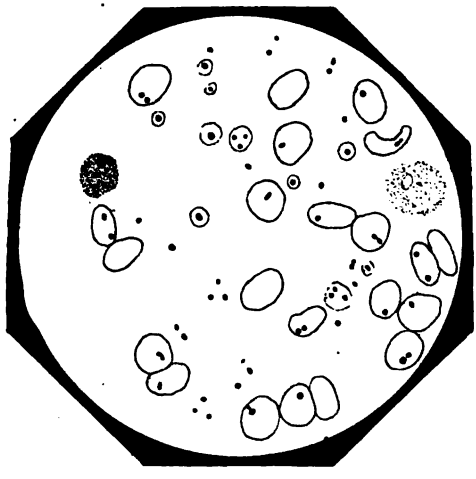


FIGURE 4.

Smear from Kidney in Texas Fever—Stained One Hour in Warm Solution of Gentian Violet. X680.

NEWPORT BRANCH.

Sweet Potatoes, Tests of Varieties, Analysis of Varieties, Economic Fertilizer Tests, Analysis of Sweet Potato Vines, High vs. Low Cultivation, Pruned Vines vs. Unpruned Vines.

BY R. L. BENNETT.

To test the comparative merits of different varieties of of sweet potatoes nine varieties were planted. Fertilized and cultivated similarly in all respects on sandy land. The table of results are here appended:

Red Bermuda	yield in	bushels	per	acre	201
Yellow Nancemond	"	"	"	"	206½
Southern Queen	"	"	"	"	213½
Shanghai	"	"	"	"	254½
Early Nancemond	"	"	"	"	200
Red Nancemond	"	"	"	"	249
Poplar Root Spanish	"	"	"	"	175
Early Jersey	"	"	"	"	264
Yellow Yam	"	"	"	"	230

Much confusion arises with the different varieties of sweet potatoes by the many different names by which the separate varieties are known. They invariably have local names in the particular locality in which they are grown, as might be expected there is great similarity between some of the so called varieties. While there is great difference in the character of tubers and vines produced by some of the varieties and some of those features of distinction are given as shown by the varieties tested.

Red Bermuda produced a large quantity of heavy vines with broad heavy leaves; the tubers were large, smooth and red color. An early variety.

Southern Queen produced a growth of vines similar to Red Bermuda but were heavier; tubers were large and smooth. An early variety.

Shanghai made the largest quantity of vines of any, which were large and coarse; leaves large; long, smooth, white tuber and very large.

Yellow Nancemond, Red Nancemond, Early Nancemond and Early Jersey all closely resemble in shape of leaves and quantity of vines produced. The leaves and vines of each are very small. They closely resemble in shape of tubers, which do not grow very large, but moderately long and smooth; one or two differ in color. All are excellent table varieties.

Poplar Spanish vines and leaves small, though it produces more vines than the Nancemonds. Tubers are very long, irregular and rough, white color.

Yellow Yam produces a medium size vine, four deeply cleft leaves which makes a broad distinguishing feature from any of above varieties. Tubers are variously sized and shaped; are smooth unless grown on very rich land. An excellent table variety.

The quantity of vines, shape and quality of the tubers of all varieties are greatly effected by the quality of soil. The best results were obtained on light sandy soil of moderate fertility.

PERCENTAGE COMPOSITION OF SWEET POTATOES AND VINES.

PROXIMATE CONSTITUENTS.	Shanghai or California Yam.	Red Nancemond.	Red Bermuda.	Southern Queen.	Yellow Yam.	Poplar Spanish.	Early Nancemond.	Early Jersey.	*Yellow Nancemond.	Vines of Yellow Yam.
Water	65.35	71.80	69.76	70.00	71.13	58.87	75.66	75.65	10.00	10 92
Ash	1.38	.95	1.00	1.08	1.03	1.45	.93	.97	11.23	8.65
Crude Protein	1.37	1.38	1.05	.98	1.63	2.23	1.16	1.29	11.56	16.25
Ether Extract	.64	.40	.42	.32	.24	.48	.29	.32	3.06	1.67
Crude Fiber	.98	1.05	.92	1.15	1.45	1.37	.96	1.07	26.06	28.08
Starch	20.84	14.52	16.34	17.98	16.64	19.45	9.79	11.39	.....	.....
Cane Sugar	6.94	6.43	3.60	6.13	5.19	6.08	5.74	5.68	.....	.....
Glucose	1.41	1.85	1.83	1.15	1.25	2.41	1.63	1.64	.....	.....
Other Nitrogen Free Matter	1.09	1.62	5.08	1.21	1.44	7.66	3.84	1.99	38.09	34.43
.....	100.00	100.00	10.000	100 00	100.00	100.00	100.00	100.00	100.00	100.00
Total Nitrogen	.22	.22	.17	.16	.26	.36	.19	.21	1.85	2.60
Albuminoid Nitrogen	.12	.16	.13	.14	.21	.27	.13	.12	1.61	2.06
Non-Albuminoid Nitrogen	.10	.06	.04	.02	.05	.09	.06	.09	.21	.54

*The vines were partially cured.

PERCENTAGE COMPOSITION OF DRY MATTER OF SWEET POTATOES AND VINES.

	Shanghai or California Yam.	Yellow Nancemond.	Red Nancemond.	Red Bermuda.	Southern Queen.	Yellow Yam.	Poplar Spanish.	Early Nancemond.	Early Jersey.	Vines of Yellow Nancemond.	Vines of Yellow Yam.
Water	65.35	.....	71.80	69.76	70.00	71.13	58.87	75.66	75.65.	10.00	10.92
Total Dry Matter	34.65	.....	28.20	30.24	30.00	28.87	41.13	24.34	24.35	90.00	89.08
Ash	3.97	3.16	3.35	3.31	3.61	3.63	3.53	3.81	4.00	12.47	9.71
Crude Protein	3.95	4.25	4.90	3.45	3.25	5.61	5.44	4.75	5.31	12.84	18.24
Ether Extract	1.85	1.70	1.40	1.39	1.08	.81	1.15	1.17	1.33	3.40	1.87
Crude Fiber	2.83	4.00	3.74	3.05	3.83	5.02	3.33	3.94	4.39	28.96	31.52
*Starch	60.15	40.77	51.50	54.04	59.94	57.64	47.28	40.24	46.76	†	.....
Cane Sugar	20.03	25.05	22.79	11.91	20.43	17.97	14.80	23.60	23.33	.....	.....
Glucose	4.07	6.91	6.56	6.05	3.83	4.33	5.85	6.69	6.74	.....	.....
Other Nitrogen Free Matter	3.15	14.16	5.76	16.80	4.03	4.99	18.62	15.80	8.14	42.33	38.66
.....	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total Nitrogen	.63	.68	.78	.55	.52	.90	.87	.76	.85	2.05	2.92
Aluminoid Nitrogen	.33	.55	.56	.43	.47	.73	.67	.52	.54	1.79	2 31
Non-Aluminoid Nitrogen	30.	.13	.22	.12	.05	.17	.20	.24	.31	.26	.61

*For methods of determining starch and sugars, see report of Chemist. †The starch and sugars were not determined in the vines.

The analyses of the varieties of sweet potatoes and vines were made by the station chemist, Prof. Geo. L. Teller. Analyses of each are given, both in the original and dry state, and are worthy of close study and comparison. The analyses are valuable in showing the difference in amounts of the same constituents in the different varieties, and also that the most favored variety, the Yellow Yam, for table purposes is not so valuable in all the important nutrients as several others. The Shanghai is a heavy producer of potatoes and vines. It has a beautiful tuber, large, smooth and white externally and internally, together with its high amount of valuable constituents make it an important potato, and deserves more attention. The palatableness of the varieties do not conform to the amount of valuable constituents, for some varieties are well flavored but rank low in per cent. of valuable nutrients.

The analyses of the vines show them to be very valuable for food for stock. They make excellent hay, and especially silage. All live stock relish them at all times. They are excellent for milk cows, though difficult to cure for hay, and impossible at the ordinary temperature. If only partially cured and housed, stock will eat them with great relish, even covered with mould. They should be siloed, which would be a vast saving, while now a waste, and considered a nuisance.

ECONOMIC FERTILIZER TEST WITH SWEET POTATOES.

Four plots were planted with the Yellow Yam. Fertilizers used were cotton seed meal, acid phosphate and kainit. The results are shown the following table:

FERTILIZERS.	Yield per acre in bu.	Increase in bu. per acre.	Amount Fertilizer used per acre	Cost fertilizer per acre.	Value increase per acre 50c per bushel.	Profit.	Loss.
Nothing	180						
Acid Phosphate	241	61	500	$ 6.50	$30.25	$23.75	
Kainit	238	58	500	3.50	29.00	25.50	
Cotton seed meal	165	15	500	6.50	7.50		$14.00

HIGH vs. LOW CULTURE OF SWEET POTATOES.

Two similar plots were selected and planted in Yellow Yam potatoes. Both were treated similarly in every respect, excepting cultivation. The following table shows results:

METHOD OF CULTIVATION.	YIELD IN BUSHELS PER ACRE.	DECREASE IN BUSHELS PER ACRE.
High	163	7½
Low	170½	

VINES REMOVED vs. VINES NOT REMOVED FROM SWEET POTATOES.

Two similar plots were selected and planted in Yellow Yam potatoes. The planting was late. On one plot when good growth of vines, four-fifths were removed. On other plots vines were allowed to remain. The following table shows results:

METHOD OF TREATMENT.	YIELD IN BUSHELS PER ACRE.	DECREASE IN BUSHELS PER ACRE.
Vines Removed	126	44½
Vines Not Removed	170½	

REPORT OF TWO YEARS' EXPERIMENT WITH GRASSES AND LEGUMES.

BY R. L. BENNETT.

In the spring of 1889 thirty-three varieties of grasses and legumes were planted to test their efficiency for this climate and the soil in its present condition, and those that succeeded best to be retained and further experimented with.

Each was sown on one-half acre plots of light sandy soil, a typical soil of this section of the State, having been cultivated more exclusively in cotton for forty years without having during that period any fertilizers applied, and, as a consequence, is worn and very deficient in vegetable matter. The grasses and legumes sown were Kentucky Blue Grass, Red Top, Meadow Fescue, Perennial Rye, Orchard Grass, Tall Meadow Oat Grass, R. I. Bent Grass, Fiorin, Meadow Soft Grass, English Rye, Timothy, Sweet Vernal, Italian Rye, Sheep Fescue, Teosinte, Alsike Clover, Alfalfa, Meadow Foxtail, Bermuda, Crested Dogstail, Hard Fescue, Wood Meadow, Rough Stalk Meadow, Slender Foxtail, Japan Clover, Seredella, Yellow Trefoil, Lupine.

It is not thought necessary to encumber this report with separate notes made upon each variety, since a large majority were failures, owing to the character of the soil, together with the inadaptability of some of the varieties to the climate and soil in question, and will not be further noted here. Of those that partially succeeded are Timothy, Red Top, Orchard Grass, Kentucky Blue Grass, Meadow Fescue, Tall Fescue, Tall Meadow Oat Grass, Sweet Vernal, Bermuda, Alfalfa, Alsike Clover, Japan Clover, Teosinte. The growth of hay of each was small, and all suffered severely from the hot, dry summer. Each remained green throughout the winter, and would have afforded very good winter and spring grazing.

Japan Clover made a good growth, from 8 to 12 inches the first season but failed the second.

Alsike Clover produced an excellent growth of hay and grew well in winter and spring.

Teosinte grew well and produced an abundance of forage.

Alfalfa grew well, attaining good height.

Bermuda has succeeded moderately.

None of the above mentioned grasses and legumes could be profitably grown for hay on soils similar to the Station's without a heavy application of fertilizers and vegetable matter to improve the mechanical condition of the soil, though some of them, we think, would serve profitably in pastures.

Orchard Grass, Timothy, Tall Fescue, Tall Meadow Oat Grass, Kentucky Blue Grass, Alfalfa, Red Top, Meadow Fescue, Bermuda, having succeeded better than others, are being further experimented with by the application of fertilizers.

FIELD PEAS.

R. L. BENNETT.

Notes Upon Varieties and Pea Vine Hay.

The abundance of superior hay produced by peas on rich and poor soils at a small cost and the high value for fertilizing induced the undertaking of variety tests. Neither the amount of vines nor peas produced by the different varieties were determined, being prevented by several weeks of wet weather which destroyed three-fourths of the hay crop in this section—but a careful description was made of each variety. All the varieties that could be obtained were planted—they are here described under the names by which they were offered for sale by the different seed houses:

Canada Field Pea—Is strictly a pea, resembles very closely the common English or garden pea, is very delicate and will not answer for farm purposes, requires very fertile soil and careful cultivation or otherwise a failure. The pea is small, round and creamy white.

White Lady Pea—A running variety very productive both of vines and peas, but both are very small. Pea is round and

white, suitable only for the table and for that a most excellent variety, well flavored.

Whippowill or Speckled Pea—The most common field variety, exceedingly prolific, but not so productive of vines—a bunch variety, very early and rapid grower. Two crops can be easily grown in one year. The vines begin to die as the peas ripen, unless grown on very moist and fertile soil. The pea is not round but slightly kidney shape, medium size. Color is brown with darker colored spots.

Red Running Pea—Produces much vines but less productive of peas, vines grow very long and lie flat, remaining green long after peas have ripened; the pods were long and well filled. Peas medium size of dark red color.

Large White Black Eye—Early bunch variety, very prolific, pods long but not closely filled—does not produce large quantity of vines, which die as peas ripen. Peas large and flat with black eyes; an excellent table variety.

Unknown Pea—Produces an enormous quantity of large coarse vines, growth of vines surpasses any other variety, remaining green and continues to produce peas throughout the season, but at same time the quality of peas was small, leaves very large, pods long and well filled. Peas medium size. Color light brown. An excellent variety for hay and ensilage.

Clay Pea—A late running variety, leaves are small, grows well on very poor soils, very productive, pods long and well filled. Peas are of bright clay color, medium size. Vines are small and remain partially green for some time after peas have matured.

Speckled Crowder Pea—Early variety, not excessive runners, very productive both vines and peas, vines do not remain green after peas have matured. Peas are extremely large. Color light brown with numerous small darker specks.

Yellow or Brown Eye Pea—A running variety, vines grow very rank and remain green long after peas have matured, produced only moderate quantity of peas, which were medium size, white with yellow or brown eye.

Of the varieties above described, for peas alone, the Whippowill and Clay peas are the best, but for hay and peas together the Whippowill is the better of the two, being earlier and vines are of better quality. For a large quantity of vines for hay, ensilage or fertilizing the Unknown pea is by far the best, next is the Yellow or Brown Eye pea, next the Red Running pea.

For table purposes the White Lady and White Black Eye varieties are the best. The bunch varieties are the earliest.

PEA HAY.

The table here subjoined to show the comparative feeding values of pea hay, timothy and millet, since they are the principle hay plants grown in the State. The figures in the table indicate the per cent. of those constituents contained in the hay of each. The analyses are from different sources:

	Water.	Ash.	Protein.	Fat.	Fibre.	Nitrogen Free Extract	Total.	Dry Matter.
Timothy	15.35	4.16	6.59	2.69	26.88	44.33	100	84.65
Millet	7.00	5.10	7.05	1.62	31.19	48.04	100	93.00
Pea Vine Hay	10.11	6.67	15.95	3.63	16.63	47.01	100	89.89

In the above table it is readily seen that pea vine hay has a decided advantage in quantity of valuable nutrients and also those nutrients are more digestible.

From the table any farmer that knows the quantity of hay that an acre of his land will produce of Timothy, Millet and Pea hay can easily calculate the amounts of crude nutrients produced by each plant per acre.

Peas are better adapted to different varieties of soil than either Millet, Timothy, or Red Clover and will produce a good quantity of hay and peas on soil too poor for others to grow. While the grasses are more or less exhaustive peas will restore.

The prevailing idea that pea vines are difficult to cure for hay has hindered its extensive cultivation and it is a mistaken idea, being but very little more difficult to preserve than Red Clover. If a little Crab grass is allowed to grow with the peas which will be done especially with the second crop if not cultivated, the pea hay will be less difficult to cure and should be mowed when the pods are first formed. It has been conclusively proven on the station that the field pea is the only hay plant that can be profitably grown for hay without fertilizers on the worn sandy cotton lands of Arkansas. While it produces a good quantity of hay the fertility of the soil is at same time improved.

FEEDING EXPERIMENT WITH STEERS.

R. L. BENNETT AND A. E. MENKE.

Information was received by the Station to the effect that butchers and packers were adverse to cattle fed on cotton seed products, claiming that such fed cattle produced an inferior quality of flesh and fat. This feeding experiment was planned therefore with special reference to determine if any the effects of cotton seed products variously combined upon quality of flesh and fat, other questions of importance also were determined. Mainly the feeding values of the rations used which were composed of the principal and most commonly grown foodstuffs in the State for feeding purposes.

In October 1890, twelve steers from two to two and a half years were bought and taken direct from range never having been accustomed to handling or feeding, four were natives others having a dash of improved blood, they were not dehorned nor allowed to run loose, but tied in stalls. All were in moderately good condition when feeding began and it will be seen in tables 1-5 they were light weight steers. The food rations were kept constant, but quantity was increased or decreased as needs of the animals demanded. The foods were not changed during the feeding period of 90 days exclusive of preliminary period of 10 days. The steers were divided into five lots and fed as shown by the respective tables. The utmost care was taken in every particular during the feeding.

The following six tables show the data obtained during the feeding period and are the means of determining the relative feeding values of the food rations used:

LOT No. 1—3 Steers.

TABLE SHOWING DATA OF INDIVIDUAL ANIMALS OF LOTS.

STEER NO.	Weight at Beginning.	Weight at End.	Pounds Food Consumed in 90 Days.	Value of Food Consumed.	Gain per Head, Pounds.	Gain per Cent.	Gain per Day, lb. per Head.	Value of Food Consumed per pound Gain.
*1	.....	.....	....	... .	.....	.....	... .	... .
2	560	802	1680 C. S. Hulls 496.9 C. S. Meal	$5 72	242	43.2	2.69	2.36
3	618	870	1784 C. S. Hulls 538.1 C. S. Meal	6 18	252	47.7	2.8	2.45

*Steer No. 1 became sick and was rejected from experiment.

LOT No. 2—3 Steers.

TABLE SHOWING DATA OF INDIVIDUAL ANIMALS OF LOTS.

STEER NO.	Weight at Beginning.	Weight at End.	Pounds Food Consumed in 90 Days.	Value of Food Consumed.	Gain per Head, Pounds.	Gain per Cent.	Gain per Day lb. per Head.	Value of Food Consumed per pound Gain.
1	618	880	1486 Corn 743 Hay	$13 45	262	42.3	2.91	5.13
2	660	844	1432 Corn 716 Hay	13 25	184	27.9	2.	7.21
3	726	958	1660 Corn 830 Hay	15 35	232	31.9	2.57	6.61

LOT N.o 3—2 Steers.

TABLE SHOWING DATA OF INDIVIDUAL ANIMALS OF LOTS.

STEER NO.	Weight at Beginning.	Weight at Fnl.	Pounds Food Consumed in 90 Days.	Value of Food Consumed.	Gain per Head, Pounds	Gain per Cent.	Gain per Day lb. per Head.	Value of Food Consumed per pound Gain.
1	650	844	1240.7 C S Hulls 374 C S Meal 876.7 Pea Hay,	$9 54	194	29.8	2.16	4.91
2	792	1040	1422.9 C S Hulls 445 C S Meal 1002.3 Pea Hay.	11 07	248	31.3	2.75	4.46

LOT No. 4—2 Steers.

TABLE SHOWING DATA OF INDIVIDUAL ANIMALS OF LOTS.

STEER NO.	Weight at Beginning.	Weight at End	Pounds Food Consumed in 90 Days.	Value of Food Consumed.	Gain per Head, Pounds.	Gain per Cent.	Gain per Day lb. per Head.	Value of Food Consumed per pound Gain
1	648	838	1009 C S Hulls 303 C. Seed 714.3 Pea Hay.	$5 63	190	29.3	2.11	2.96
2	772	934	1034.1 C S Hulls 316. C. Seed 739.3 Pea Hay.	5 80	162	20.8	1.8	3.58

LOT No. 5—2 Steers.

TABLE SHOWING DATA OF INDIVIDUAL ANIMALS OF LOTS.

STEER NO.	Weight at Beginning.	Weight at End.	Pounds Food Consumed in 90 Days.	Value of Food Consumed.	Gain per Head, Pounds.	Gain per Cent.	Gain per Day lb. per Head.	Value of Food Consumed per pound Gain.
1	604	760	1303 Pea Hay 360 C. Seed.	$8 55	156	25.8	1.73	5.48
2	660	850	1303 Pea Hay 360 C. Seed.	8 55	190	28.8	2.11	4.5

TABLE No. 6.

AVERAGE OF FIVE LOTS.

LOT NO.	Average Weight at Beginning.	Average Weight at End.	Average Quantity of Food Consumed in Ninety Days.	Average Value of Food Consumed in 90 Days.	Average Gain per Head per Lot.	Average Gain per Cent.	Average Gain per Day.	Average Value of Food Consumed per lb Gain.
1	589	836	1732 Cotton Seed Hulls, 517.5 " " Meal.	$ 5 85	247	45.4	2.74	2.40
2	668	894	1526 Corn, 763 Pea Hay.	14 02	226	34	2.49	6.32
3	721	942	1331.8 Cotton Seed Hulls, 409.5 " " Meal, 939.5 Pea Hay.	10 30	221	30.5	2.45	4.68
4	710	886	1021.5 Cotton Seed Hulls, 309.5 " Seed, 726.8 Pea Hay.	5 71	176	25	1.95	3.27
5	632	805	1303 Pea Hay, 306 Cotton Seed	8 55	173	27.3	1.92	4.99

TABLE No. 7.

PERCENTAGE COMPOSITION OF FOODS USED IN FEEDING EXPERIMENT.

FOODS.	Ash.	Crude Protein.	Crude Fat.	Crude Fibre.	Water.	Nitrogen, Free Matter.	Total.	Total Nitrogen	Albuminoid Nitrogen.	Non-Albuminoid Nitrogen.
*Pea Hay	6 97	10.07	1.57	30.70	11.41	39.28	100.00	1.61	1.24	.36
Cotton Seed Hulls	2.52	4 .83	.80	50.48	10.55	30.82	100.00	.77	.71	.06
Corn Cob	3.56	7.87	3.56	7.20	14.65	63.16	100.00	1.26	1.26	.00
Cotton Seed Meal	5.70	42.00	7.36	9.85	11.36	23.73	100.00	6.72	5.78	.94
Cotton Seed	6. 42	19.54	22.83	29.95	12.61	10.45	100.00	3.11	2.60	.51

*Pea hay was at an advanced stage when mowed hence the large per cent. of fibre.

DISCUSSION OF TABLES 1 TO 6.

The values of the different food stuffs are an average of prices for several years in this immediate section. The prices of cotton meal and hulls were those at the oil mills. The value of feed and cost of pound gain can be calculated for any other section of the state. In looking over the different tables the individual peculiarities of the animals will be readily seen, especially in the quantities of the same food consumed by different animals to produce a pound gain. Also the great difference in the feeding qualities of the different animals. Those steers that had a slight quantity of improved blood surpassed the natives, or scrubs, and proved themselves far more profitable in every respect. It will be sufficient to state without giving in tables, that each animal required an increase in quantity of food as they increased in live weight; also that the gain in weight during the period was subject to fluctuations. From the high cost of the gain in some instances, as shown in the tables it may cause some to believe that it is unprofitable to feed cattle for beef, but that is not a fact in every case, for the original weight of the animal, if not then in a condition for beef has been increased in value by the feeding process which, though apparently costly, may return a good profit. Cotton meal and corn were the costliest foods used, the cotton meal costing five times as much as cotton seed. In comparing the averages of lots 3 and 4 in table 6, it is readily seen that the great difference between the gain per day is in favor of lot 3, fed cotton meal instead of cotton seed, while the proportions of the different foods that compose the rations for the two lots are the same, but the cost of the food per pound gain is in favor of the lot fed cotton seed. The valuable manure from each lot, if estimated, would considerably reduce the cost of feeding. There was no difference in appearance due to the food of the lot fed cotton meal and cotton hulls from the lot fed corn and pea hay.

SUMMARY OF FEEDING PERIOD.

The results of the feeding period as given in table No. 6, representing the averages of each lot shows that cotton hulls

and cotton meal was decidedly the cheapest rations used and produced the greatest gain per day and per hundred live weight and was equally relished as any ration throughout the period. It ranks in every respect over the other rations.

The repective values of the other rations are plainly shown in the table, and need no comment.

High cost of gains is not always to be considered as inconsistent with profitable feeding animals for beef.

SECOND PART OF EXPERIMENT.

SLAUGHTERING.

The feeding period completed previous to slaughtering: The cattle were shipped immediately to Armour Packing Co., Kansas City, to determine the main object of the feeding experiment by the effects if any of cotton seed products when fed to cattle on quality of flesh and fat. While the cattle were very small and two or three not in such good condition as they could have been, the feeding period which was essentially 100 days was sufficiently long and the gains during the period were enough to give the foods ample opportunity to produce any effect they might be capable of. While in transit the steers were to some extent neglected by the railroad, but all suffering alike would not to any appreciable extent effect the results to be determined. Every care and precaution was taken to prevent any error. The slaughtering was done uuder the Station supervision and the utmost accuracy was exercised in every detail. The following tables eight and nine contain data of individuals and lots from slaughtering:

TABLE No. 8.

LOT NO.	Steer No.	Live Weight.	Dressed Weight.	Per Cent. Dressed to Live Weight.	Tallow.	Rendered Tallow.	Total Tallow.	Per Cent. Tallow to Dressed W'gt.	Melting Point. Tallow.
	*1	.....	.....	.....	.....	.....	.....	.....	.....
1	2	730	408	55½	28	7	35	8	51.2°C
	3	800	427	53½	36	9	45	10	49.6°
	4	860	483	56	33	8	41	8	46.4°
2	5	800	436	54	34	8½	42½	9½	47.6°
	6	930	526	56	39	9½	48½	9	47.1°
	7	800	453	56	28	7	35	7	50.5°
3	8	1010	571	56	42	10½	52½	9	47.9°
	9	790	430	54	28	7	35	8	50.6°
4	10	860	490	56	25	6	31	6	51.2°
	11	720	380	52	21	5	26	6¾	50.2°
5	12	780	428	55	27	6½	33½	7¾	50.2°

*No. 1 rejected for sickness.

TABLE No. 9.

LOT NO.	Average Live Weight at Slaughtering.	Average Dressed Weight.	Average Per Cent. Dressed to Live Weight.	Average Tallow.	Average Rendered Tallow.	Average Total Tallow.	Average Per Cent. Tallow to Dressed Weight.	Melting Point. Tallow.
1	765	417½	54½	32	8	40	9	50.4° C
2	863⅓	481⅔	55	35⅓	8⅔	44	9	47.°
3	905	512	56	35	8¾	43¾	8	49.2°
4	825	460	55	26½	6½	33	7	50.9°
5	750	404	53½	24	5¾	29¾	7	50.2°

DATA OBTAINED FROM SLAUGHTERING.

The steers were weighed just before slaughtering. The loss in weight while in transit can be seen by referring to tables Nos. 6 and 8. The data obtained by slaughtering are: Live weight, dressed weight, tallow, butter fat and melting point of tallow. Each is respectively shown in table No. 8, together with percentage. Table No. 9 contains averages for comparison of lots. The data in the two tables, Nos. 8 and 9, are essential for computing per cent. tallow to dressed weight for comparing lots, for comparing lots is the only manner of arriving at correct conclusions without being influenced by individuality.

In table No. 8, the per cent. tallow to dressed weight rendered by lots conforms to the gains produced by the lots as shown in table No. 6, and is in accordance with the feeding values of rations used. The melting point of tallow cannot be used in comparing lots, only individuals. Neither does the melting point stand in any relation to the per cent. tallow to dressed weight, but only as shown those animals producing the greatest gain during the period had lowest melting point, though the melting point from the meal and hull steers stands much higher in relation to gain than any other lot.

REPORT OF ARMOUR PACKING COMPANY.

It was requested of the Armour Packing Company that they slaughter the steers and collect the usual data as is given in table No. 8; also to report upon the beef and tallow as to its several merits and demerits, while in process of the various manipulations and in the cold-dressed stage; then to select similar parts from the dressed beef of the animals, and test the cooking and flavoring qualities of each. Their facilities and ability necessary to make a report on the above points thoroughly trustworthy and accurate, need not be questioned. The report is here given as rendered. It is seen that the animals were known only by numbers. Significance of the numbers are given below the report.

ARMOUR PACKING COMPANY,
DRESSED BEEF DEP'T,
KANSAS CITY, U. S. A., Feb. 20, 1891.

Arkansas Agricultural Experiment Station, Fayetteville, Ark.:

GENTLEMEN—We would respectfully make you a report, giving our opinion as to the merits and demerits of the eleven (11) head of cattle sent us from your establishment with the request that we slaughter same and report to you our opinion. The specimens of Butter Fat and Tallow, as selected by your Mr. Bennett while here, were sent you by express, and we sincerely hope that same arrived at Fayetteville in good shape.

LOTS 1 AND 5—5 CATTLE.

The Tallow in these lots we consider very much the best; in fact, it is our opinion that the Tallow is exceedingly good, taking into consideration the size of the bullock, with, perhaps, the grade of the cattle.

LOT NO. 2—2 CATTLE.

We consider the Tallow good, say, pretty good medium grade; but not at all in good comparison with lots Nos. 1 and 5.

LOTS NOS. 3 AND 4—4 CATTLE.

The Tallow is only fair. Would judge that method of feeding in this case would indicate that it is not proper food for making a good grade of Tallow; in fact, there was only one bullock in this lot that would make even a fair showing. The others were very lean, and only marketable at a very low figure.

NO. 2R IN LOT NO 5.

Makes a very good showing—the very best gain in Dressing, Tallow and Quality—far superior to the others.

We would state most positively to having made a thorough test of the eating qualities of both lots Nos. 1 and 5 and lot No. 2, and they were excellent, good, tender, juicy beef. The other beef very naturally, in accordance with report as to condition, did not prove very palatable—very dry and tasteless. We were very sorry, indeed, that the cattle did not arrive here in better shape, as we understand they were very much neglected

by the railroad company; but we made a very careful test of the matter, and sincerely hope this information may be of value to you.

Any time we can be of further service to you, we would be very happy indeed to give you both our time and attention, and with kind regards, we remain,

Yours truly,

ARMOUR PACKING CO.

SIGNIFICANCE OF NUMBERS.

Lot 1—3 Steers—Fed corn and pea hay.
" 5—2 " —Fed cotton meal and hulls and pea hay.
" 2—2 " —Fed cotton meal and hulls.
" 3—2 " —Fed cotton seed and pea hay.
" 4—2 " —Fed cotton seed, cotton hulls and pea hay.

From the above report on grades of tallow, it will be seen that cotton hulls and meal fed steers stand second in grade fo tallow, while corn and hay and meal, hulls and pea hay, (two lots), rank first, but no conclusion can be drawn from that adversely to cotton products, for No. 2R, lot 5, fed cotton hulls, meal and pea hay rank them all, while No. 1, of same lot, does not rank equally with steers in lots 1 and 2, therefore, such a conclusion that might be adversely to steers fed cotton meal and cotton hulls is at once disproven. In comparing reports of lots 4 and 5, the superiority must be attributed to cotton meal in the rations. (See tables 3 and 4). The condition of the steers in lots 3 and 4 must be attributed to the foods and the grade of the animals.

The above report reaffirms and substantiates the individuality of the animals brought out so prominently in the feeding period. Coming, now, to the report on the palatableness and edibleness of the lots, the rations effecting directly as their feeding values in producing gain during the feeding period, lots 1 and 2 are of equal rank—one fed corn and pea hay; the other fed cotton hulls and cotton meal.

CONCLUSION.

Therefore, summing up the data obtained from the feeding and slaughtering of the 11 steers, the conclusion is that there was not detected through the usual manner of manipulating beef, no detrimental effects from cotton seed products fed to the animals.

Such having been arrived at after much painstaking work and expense, can be accepted by feeders and packers with the utmost confidence.

When, considering the quality, cheapness and high feeding value of cotton seed products, the value of this experiment is apparent.

ACKNOWLEDGEMENT.

I cannot express in too warm terms my appreciation of the kind hospitality and numerous courtesies extended to the Station by the representatives of the Armour Packing Company. To them for their interest manifested in the experiment and care exercised to obtain accurate data, I am especially grateful.

R. L. BENNETT.

EXPERIMENTS AT PINE BLUFF.

THE BEST SOURCE OF NITROGEN.

BY R. M. BAKER.

Previous work having shown that nitrogen was a much needed ingredient in fertilizers for this locality a series of tests were made as undermentioned. The rows were laid off in April 3½ feet wide by 70 yards long.

The fertilizers were applied by hand in the furrow, the first week in May and the land ridged with a two horse plow, middles thrown out with a one horse plow. A tooth harrow was passed over the beds just before planting.

The cotton was planted on May 7th with a Banner Planter about one bushel of Peterkin being used to the acre, the subsequent cultivation was the method heretofore adopted and described:

Fertilizers used, pounds per acre.	Seed Cotton.	Lint.
200 Cotton Seed Meal	798	264
300 Cotton Seed Meal	846	270
360 Dried Blood	660	204
Nothing	678	228
360 Leather Scrap	720	276
120 Sulphate of Ammonia	714	240
144 Nitrate of Soda	744	252
300 Cotton Seed Meal	840	240

VARIETIES OF COTTON.

We obtained several untried varieties of cotton for comparison with well known kinds they yielded as follows:

		Seed.	Lint.
1.	Peterkin	480	120
2.	Jones' Improved	640	200
3.	Duncan's Mammoth Boll	740	260
4.	Okra	480	125
5.	Southern Queen	720	280
6.	Talbot's Improved Allen	600	200
7.	Georgia Prolific	720	300
8.	Mammoth Prolific	860	300

9.	Dickson's Cluster	680	240
10.	Peerless	640	260
11.	Truit's Premium	700	220
12.	Hawkins	540	200
15.	Allen	580	200
17.	Maxeys	800	280
18.	Pettit Griff	920	340
22.	Cherry	640	260
23.	Boyd's Prolific	640	256
25.	Tennessee Silk	500	200
31.	Dickson's	500	200
32.	Oats	400	180
26.	Shinn's Early	660	280

The yields are all small owing to late planting.

ECONOMIC EXPERIMENTS WITH FERTILIZERS.

The method of planting and cultivating employed for these experiments was the same as before mentioned. The object was to ascertain what quantities of fertilizers per acre will give the largest per cent. of profit:

Mixture 1, { 6 parts Cotton Seed Meal, 2 parts Acid Phosphate.

Mixture 2, { 6 parts Cotton Seed Meal, 2 parts Acid Phosphate, 1 part Kainit.

Pounds Per Acre Used.		Cotton Seed.	Lint.
	Blank	780	360
300	No. 1	1220	400
337.5	No. 2	1200	460
	Blank	810	270
400	No. 1	1500	520
450	No. 2	1120	380
	Blank	760	255
500	No. 1	1220	360
562.5	No. 2	1620	500
	Blank	800	260
700	No. 1	1380	460
787	No. 2	1760	560
	Blank	790	250

900	No. 1	1480	560
1012	No. 2	2020	740
	Blank	810	280

These results are confirmatory of those obtained last year showing that No. 2 was the better mixture.

GENERAL FERTILIZERS ON COTTON.

The object of this set of experiments was to try the effect of fertilizers in different forms:

Fertilizers used. (Pounds Per Acre.)	Seed Cotton.	Lint.
Nothing	750	260
200 Kainit	720	240
200 Acid Phosphate	680	240
200 Cotton Seed Meal	920	306
300 Cotton Seed Meal	900	300
300 Acid Phosphate	710	270
300 Kainit	820	370
Nothing	760	260
150 Kainit, 150 Acid Phosphate,	760	270
150 Kainit, 150 Cotton Seed Meal,	850	280
Nothing	720	240
150 Acid Phosphate, 150 Cotton Seed Meal,	960	320
200 Kainit, 200 Acid Phosphate,	800	270
200 Kainit, 200 Cotton Seed Meal,	900	300
200 Acid Phosphate, 200 Cotton Seed Meal,	1020	340
200 Acid Phosphate, 200 Cotton Seed Meal, 200 Kainit,	960	320
Nothing	750	250

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Agricultural Experiment Station.

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FINANCIAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

OF THE

INDUSTRIAL UNIVERSITY of ARKANSAS

In Account with the United States Appropriation.

1892.	DR.		
To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30th, 1892, - - - -			$15,000.00
1892. JUNE 30TH.	CR.		
By Salaries, - - -		$8,237.95	
By Labor, - - - -		1,027.42	
By Sundries, - - -		908.35	
By Technical Apparatus, -		376.17	
By Chemicals, - - -		373.02	
By Seeds and Trees, - -		157.34	
By Library, - - -		38.45	
By Implements, Machinery and repairs for same, - -		114.80	
By Feed, - - - -		442.29	
By Freight and Express, -		55.43	
By Newport Station, - -		1,046.22	
By Pine Bluff Station, -		284.21	
By Expense of Stock, -		403.40	
By Printing, - - -		864.91	
By Travel, - - -		503.75	
By Building, - - -		681.00	$15,914.71
Excess of Expenditures over Receipts, -			$ 514.71

The foregoing Statement is taken from the books of the Experiment Station.

R. L. BENNETT,
Director.

REPORT OF DIRECTOR.

Since the Fourth Annual Report the work of the Station has been more thoroughly systematized, expenses reduced, and work considerably extended. While the completed work for this year is not as much as would have been had the Station staff been complete at the beginning of the calendar year 1891, and other conditions more favorable and systematic. Four bulletins have been published and the full text of each appears in the succeeding pages. In the future, the work of each department of the Station will be published alone in one bulletin and mailed to the public, so five bulletins will be issued annually, two of which will appear from the Branch Stations or agricultural department.

New horticultural grounds have been secured and laid out in systematic order and many new varieties of fruits planted thereon. Full and complete records of all fruits will be kept and to the originators of new fruits and vegetables sent to the Station for trial, assurance is given that they will receive a careful and thorough trial and be reported on in due time.

The veterinarian or animal pathologist will in the future investigate fungus diseases of plants as well as of animals, which will be an extension of the station research and facility to be of assistance to the farmers and fruit growers.

Considerable additional technical apparatus has been added to the chemical and pathological laboratories during the year, so fitting them for more complete and satisfactory work. The two Branch Stations have been improved by the erection of necessary buildings for experimental work.

The grounds have been very much improved and new and improved machinery purchased. At Newport a nice hall has been built which serves a double purpose, an office for the Station and an assembly hall wherein are held monthly the meetings of the White River Agricultural and Stock Breeders' Association.

The facilities of all departments of the Station and branches have been increased, consequently the quality and volume of the Station work will be increased.

A Branch Station has been ordered established this fall in the southern part of the State, at or near Camden.

At Newport and Pine Bluff Stations splendid success has attended the wheat and oat experiments. The experiments are particularly valuable since that is the cotton section of the State, where it has been believed that grain could not be successfully and profitably grown. The same was thought to be true of grass and clover, but both, with proper treatment, have succeeded well.

Voluntary requests for bulletins and inquiries for information are constantly increasing, which is an indication that the farmers are taking more interest in the work of the Station. The mailing list comprises about 7,000 names, 6,500 of which are in the State and when the names of leading farmers in the State reach us or those whom we think desire bulletins, their names are entered on the list for future publications, so the number of bulletins distributed is constantly increasing by voluntary calls and by the efforts of the Station.

RINGWORM.

NATURE AND TREATMENT OF A PREVALENT SKIN DISEASE OF YOUNG CATTLE.

ARKANSAS INDUSTRIAL UNIVERSITY

Agricultural Experiment Station,

FAYETTEVILLE, ARK.

BULLETIN No. 16.

JULY, 1891.

The Bulletins of the Station are Sent Free to All Residents of the State who Request them.

ARKANSAS INDUSTRIAL UNIVERSITY.

AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

HON. J. T. HINDERSON. HON. W. H. LANGFORD. HON. B. C. BLACK.

THE PRESIDENT OF THE UNIVERSITY. THE DIRECTOR OF THE STATION.

STATION OFFICERS.

R. L. BENNETT..... Director.

GEO. L. TELLER..... Chemist.

R. R. DINWIDDIE..... Veterinarian.

..... Entomologist.

J. F. MCKAY..... Horticulturist.

F. W. KILLEN..... Assistant Chemist.

B. M. BAKER..... Assistant at Pine Bluff.

..... Assistant at Newport.

..... Assistant at Fayetteville.

RINGWORM.

Nature and Treatment of a Prevalent Skin Disease of Young Cattle.

Under this name I describe an affection of the skin of cattle familiar to farmers in this and most Western States under the name of "White Scab." It probably also is known under other local or popular names. The disease is one of the several contagious skin affections to which cattle are subject, and which prevail more or less in the herds of the West and Southwest. Stockmen, without knowing the true nature of these diseases, yet generally recognize their contagious character and adopt, on the plains, methods of treatment which experience has shown to be effectual. This consists in the wholesale application of antiparasitic remedies, usually a mixture of lime and sulphur in water, applied to the whole surface of affected animals. This treatment is commonly successful in destroying the parasites.

It is probable that those severer forms of contagious skin diseases which sometimes prevail among both cattle and horses on the Western and Southwestern plains are due to "mange" and not ringworm. However, as I have said, ringworm seems at times to occur there also.

The occurrence of this so-called "White Scab" in a herd in the neighborhood of my laboratory, allowed me the desired opportunity of establishing its nature and symptoms, and its identity with ringworm.

The name "ringworm" is derived from human pathology, and is here retained because of the similarity of the disease now under consideration with ringworm of man. This similarity refers to its exciting cause rather than its outward phenomena, because ringworm in cattle does not in every respect present the same characteristics as in mankind.

That the same parasite is the cause of both is shown by the transmissibility of the disease, that is, its transmission to mankind from animals, as well as by the similarity of its microscopic phenomena.

In yearling cattle we find this disease much the most frequently. It often passes through all the animals under two years of age in a herd, leaving the older ones unaffected. Suckling calves, however, do not seem to be very susceptible.

It occurs in winter, both in cattle which are stabled and in those which are wintered in the field or on the range. There seems to be an intimate connection between the occurrence of this disease and a deficiency of good pasture, showing the simultaneous operation of both predisposing and exciting causes in the production of ringworm in cattle. By this is meant that the system, and, therefore, the skin, is affected by the absence of the succulent grasses of spring and sumnier in such a way as to confer on the latter a susceptibility to the attack of the parasite of ringworm which, at other seasons, it does not possess. This subject of susceptibility will be referred to again in speaking of the transmission of the disease.

Site.—In calves and young cattle generally we find the diseased patches occurring for the most part on the face, neck and along the spine. A very favorite position is on the skin surrounding the orbits. Here it may, and often does, extend completely around, invading the eyelids quite to their free margins. In such a case the surface of the eyeball becomes irritated and inflamed, and, in rare cases, as I am informed, permanent blindness in the affected eye results. More commonly the superficial ophthalmia subsides with the removal of its cause without leaving any permanent injury. The cause is no doubt merely the thickening and roughening of the eyelids and the presence of scales and other debris detached from the diseased eyelid above.

There is no reason for believing that the parasitic fungus which invades the hair and skin externally, also grows within the eyelids to give rise to this eye complication.

Other favorite sites are on the pinna of the ear or at its base, also the sides and lower surface of the neck or near the root of the tail. In calves it does not extend continuously over any great extent of the body.

Symptoms.—In a case in which the disease is well established we see on one or more of the above named situations patches of skin partially denuded of hair, raised, as a rule, above their surroundings, and presenting a grayish white, rough or scabby appearance.

These patches vary much in size. In shape they are generally somewhat rounded in outline when small, but larger patches are often irregular in shape.

The characteristic circinate appearance which ringworm patches *(Tinea Circinata)* present in man can seldom be recognized in cattle; as a rule the whole surface of a diseased patch has the same appearance.

The affected spot is rather sharply circumscribed, but we sometimes see in its immediate neighborhood smaller secondary spots which evidently have had their origination by transferance of the contagion from the first.

A ringworm patch in cattle appears at first glance to be quite bald, but closer examination shows that it is covered with short scattered hairs, comparatively few in number and only slightly projecting above the surface. These hairs usually remain in position when the scabs or thick layer of scurf is forcibly removed and when then pulled on come out by the roots, or, less commonly, break off near the surface, in the former case retaining, as a rule, their root sheaths.

The scurf or "scab" is composed, for the most part, of desquamated epidermal cells, containing, in considerable quantity, the fungus threads and spores which are always associated with this disease. The surface is dry, and, when rubbed, a fine scurf readily comes off. By more forcible scraping, the whole of this scabby or scaly covering is removed, exposing a smooth surface, showing, perhaps, a few points of blood.

In ringworm of cattle the eruption is chiefly squamous in

character. Vesicles are rarely seen at any stage of the disease. When the disease is artificially transmitted, one can observe the process from its commencement. In twelve to fifteen days from the time when the contagion is applied the surface feels roughened to the fingers, and careful examination reveals the presence of a number of small papular elevations, reddened at the base and desquamating at the top. The intermediate parts are covered with loose scales and much of the hair falls out. The surface remains dry, unless it becomes abraded by rubbing, but itching seems to be comparatively slight in cattle. Where the animal does rub the place, it may give rise to further thickening of the skin, with cracks or abrasions which readily bleed when handled.

Symptoms in the Horse.—In the horse the disease, when conveyed from cattle, seems to spread more rapidly and cause greater irritation. It is readily transmitted artificially, more readily than to cattle themselves. The affected place is more completely denuded of hair, the surface smoother and more scurfy and there is an absence of the accumulated, partially detached masses of scales which, in cattle, give the patch a scabby appearance. Owing to the skin of the horse being more sensitive, we have here a greater degree of itchiness, and as a consequence, more rubbing and abrasion of the cuticle. The tendency to spontaneous recovery, which is a notable feature of this form of ringworm in cattle, is less marked in the horse.

The disease is probably transmissible to all the domesticated animals, but the symptoms special to each need not be enumerated. Any differences observed depend chiefly on the degree of sensitiveness of the skin and the consequent intensity of the inflammatory reaction.

When transmitted experimentally to white rabbits the growth of the fungus causes a considerable erythematous inflammation, with itching and baldness of the affected spot.

All dermatologists recognize the transmissibility of ringworm from the lower animals to mankind. As I have shown,

experimental infection of other domestic animals is not difficult, but I have not observed that adult human infection is common from this form of bovine ringworm.

Diagnosis.—This should not be difficult to any by whom the above description has been carefully read. The season of the year—winter or early spring—age of the cattle, situation of the diseased spots and their appearance, together with the manifest tendency of the affection to spread through a herd, should be our guides. For those who possess a microscope and are able to handle it, the diagnosis is particularly easy, since the appearance of the fungus threads and spores and their relation to the hairs are quite characteristic.

Causes.—The parasite which is associated with this disease can be seen by soaking some of the scales above described for about twelve hours in a moderately strong solution of potash and examining the same under the microscope with a magnification of 100 diameters or more.

The scurfy mass is composed of epidermal scales, parts of broken and entangled hairs and fungus threads and spores.

The fungus elements are found in great abundance in the hairs and surrounding them. The relation of the fungus to the hairs can be best demonstrated in the short hairs which have been pulled out by the roots after removal of the superficial scabby mass from a diseased patch.

The cells of the root sheath which may come out with the hair are not usually affected, but masses of vegetable cells or spores *(conidia)* may be seen surrounding the hair above the beginning of the attached cells of the sheath. These parasitic cells or spores are thickly grouped together, without any evident linear arrangement. They are, for the most part, spherical. At the outer edge, where the mass is thinner, a few filaments, more or less segmented, as well as spores arranged in linear series, can be seen.

In the hairs, running chiefly in the direction of the hair fibres, are long rows of the same cells which penetrate in the substance of the hair down to a point lower than the beginning

of the sheath and lower than they are seen on the outside of the hair. The strings of vegetable cells may reach to the bulb of the hair, but it is not usual to find them extending quite to this extremity.

In the hair we find: (Fig. 1.)

(1) Cells resembling those around it, spherical in shape and not distinctly in rows; these are not numerous.

(2) Rows of cells, of considerable length, running in the direction of the long axis of the hair. These cells or spores are closely apposed to each other, and are not spherical but quadrangular in shape.

(3) In places we recognize filaments or threads of the same thickness as these chains, or, in some cases, less, in which no segmentation can be noticed.

These are the forms in which the fungus shows itself in the hair. In the scales we find the same elements, but filaments are here more common and the fungus is always most abundant in the neighborhood of an entangled hair. Many such hairs or parts of hairs seem to be a solid mass of fungus spores.

In size, the spores average, when in chains, as they are usually found in the hair 3.5 micromm.; the filaments average about 3 micromm. in width. The filaments may show scattered granules, but vacuoles are not seen, and branching is not very frequent. Short, abortive branchlets are not uncommon. The size of the fungus elements (spores and mycelial threads) does not appreciably vary in cattle and horses.

The Trichophyton tonsurans. In human pathology this parasite, by its growth in the skin gives rise to various forms of disease, all included under the common designation of "ringworm," the differences being due to the various positions in which the parasite is found. This affection in young cattle, with which we are dealing, corresponds to ringworm of the scalp of children (*Tinea tonsurans*) and the fungus parasite above described seems to be identical with the *Trichophyton tonsurans* long since discovered in human ringworm. Botanists have, for the most part, been reluctant to recognize this fungus

otherwise than as a modification of some common mould, but the researches of Grawitz, Quincke and others by aid of modern bacteriological methods seem to prove it a distinct species. It is placed with the *oidium lactis*, intermediate between the true moulds and the sprouting fungi or yeasts. Grawitz has proved its undoubted pathogenic or disease producing property, that is, he has shown it to be the immediate cause of ringworm. However, as has been said above, there is also very manifestly in cattle at least, a certain condition of the skin necessary for its growth.

Transmission. In testing the contagiousness of this bovine form of ringworm, I found that scales taken from a diseased patch and rubbed dry on another animal or on another part of the same animal seldom produced infection. If, on the other hand, the skin was well soaked with water, or the scales rubbed up in a mortar with water and then applied the disease was almost certainly reproduced. Under these latter conditions it was not found necessary to either cut or scrape the surface where the spores were applied, the moisture supplied evidently being available for the first sprouting of the transferred spores. This was in winter and early spring. Later, when the cattle obtained an abundant supply of good pasture it was impossible to produce any appreciable artificial infection, and further, those animals which already were considerably infected underwent spontaneous and rapid recovery with complete return of the hair, and without any trace of the disease remaining. The cattle which I had been observing were fed during winter on corn, cotton seed meal and hay, also during part of the time on ensilage; when a sufficient supply of grass was obtainable all these were discontinued. Cattle which receive no concentrated food in winter also suffer from this disease, so that we may suppose that the necessary susceptibility of the skin to the growth of the *Trichophyton* is due to the lack of fresh pasture rather than the effect of any special kinds of food. No doubt the shedding of the hair which naturally occurs in animals in the spring largely contributes to the removal of the fungus from the skin.

Horses are readily infected from cattle experimentally, and where cohabitation with the latter is allowed natural infection may easily occur. Under such circumstances it is a common occurrence to find both the cattle and horses on a farm affected. Horses of any age may suffer. In these the growth causes more complete baldness, and in some cases, at least, extends over greater surface of the body than in cattle.

The *importance* of this disease depends upon:

1. Its effects on the cattle themselves.

2. Its effects on horses which may become secondarily infected.

3. The risk of the disease being communicated directly to the attendants of these animals or indirectly to the children of the household.

1. *Its effects on cattle.* These animals, possessing as they do, a comparatively insensitive skin, do not suffer apparently to any great extent from the itching which is a usual symptom of ringworm, but if a large surface is involved in the disease it doubtless interferes to some extent with their growth, and if a whole herd be attacked the aggregate loss must be considerable.

Badly infected calves are very commonly in poor condition, but this is not an invariable rule.

The complication affecting the eye has been already alluded to.

2. *On horses* ringworm is a more serious affection than on cattle. It produces complete baldness of the affected spots, and although in time it here also tends to recovery, this process may be delayed, and in the meantime the disease spread to others by grooming or by contact. Hence transferrence to these animals ought especially to be guarded against.

3. Ringworm in mankind is usually a consequence of contact between the healthy and diseased of the same species.

It is not likely that cattle are very frequently the means of infecting the human race directly, although the possibility is admitted.

Children are more liable to ringworm than adults, but they do not often come in contact with cattle.

Where cattle are responsible for human ringworm it is indirectly by infecting cats or dogs which may then convey the disease when handled by children.

Human adults, however, no doubt do sometimes receive ringworm when frequently handling or grooming horses or cattle so affected, especially if, through ignorance of the nature of the disease, no precautions are taken to avoid it. Cleanliness of the skin is perhaps the most important of these precautions. In certain tropical countries infection in this way is said to be a common occurrence among the natives.

Sanitary measures and treatment. The first and most important point in this connection is the early recognition of the disease, so that preventive measures may be adopted before it spreads through the herd, and possibly extends to other species of animals. An animal which is found to be suffering from ringworm ought at once to be separated from the others and treated according to the directions given below. We do not know that ringworm always originates by contagion between diseased and unaffected animals. It is possible that the *Trichophyton* may be a facultative parasite, that is, may in general lead a non-parasitic life, with the power, however, under suitable conditions, especially indicated by an altered or unclean condition of the skin, of adapting itself to a parasitic existence. (According to Grawitz the fungus grows at summer temperature,—best about 30° C.—on acid artificial culture media without losing its faculty for parasitic growth on the skin.)

However this may be, it is certain that when once established the disease is spread by contagion in animals as well as in the human race.

Other cattle or horses should not be groomed with any brushes or combs which have been used on diseased cattle. Where it occurs among stabled cattle thorough cleaning and whitewashing of the stable is indicated as well as burning of the

bedding and disinfection of halters. Individual animals are best treated in the following way:

The hair is clipped close for some distance around the diseased patch, and the latter well soaked and washed with hot water and soft soap. To prevent dissemination of living spores the water ought to contain some fungicide. (Equal parts of water and 1-500 solution of corrosive sublimate is applicable for this purpose, remembering always that this solution is a poison). After the scales have been removed by this means, apply over the diseased part an antiparasitic remedy. Among the remedies recommended for the purpose are tincture of iodine, iodine ointment, citrine ointment, solutions of corrosive sublimate, carbolic acid and sodium sulphite. All of these and many others are effective when thoroughly and frequently enough applied. When mild remedies are desired, I have found the iodine ointment or tincture most suitable, and recommend these for use when the disease is situated above or close around the eye. The tincture is best applied with a small brush or sponge fastened to the end of a short stick of wood, whilst the ointment may be rubbed in with the fingers. Both preparations must be thoroughly rubbed into the diseased part and also some distance around it, and the application repeated daily for a week or more.

In other situations a more prompt cure may be expected from the use of stronger preparation, such as citrine ointment (nitrate of mercury ointment), or, in my experience, still better, a blistering ointment composed of red iodide of mercury one part to six of lard, and a few drops of croton oil. One application of this last remedy will effect a cure wherever applied, but it should not be used over too great a surface nor in the neighborhood of the eye, nor should it be re-applied to the same place. All remedies may be washed off twenty-four hours after being applied. In horses the iodine ointment, nitrate of mercury ointment and carbolic solution (20 per cent. in glycerine) are suitable; they must be repeated, and if necessary changed or combined until recovery is obtained.

Harness which has been in contact with diseased patches

here require attention also. Thorough cleansing by scraping and washing, and then soaking with the disinfecting solution are the means to be pursued to prevent extension of the disease in this way.

In both cattle and horses I would recommend when possible, a change of diet, especially to good pasture. Beside this, there is no special diet which in animals can be said to be antagonistic to ringworm, although in *tinea tonsurans* of children, fatty articles of diet are recommended by all authorities.

In the way of internal medicinal remedies, there is nothing which can be recommended for all cases. Where there is manifest digestive disorder, this will require treatment according to the symptoms presented, but preparations of arsenic, etc., which are often given in skin diseases, should not be used except under skilled supervision, and therefore are not recommended here.

FIGURE 1.
Part of hair from ringworm patch of calf. X94.

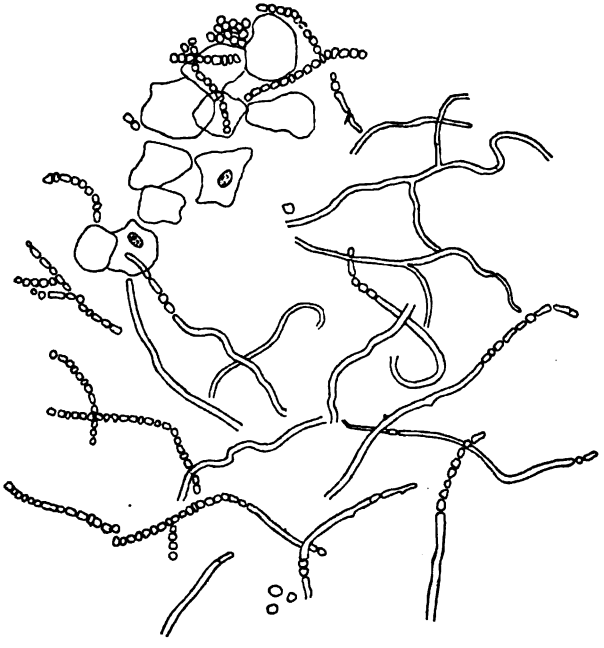

FIGURE 2.
Mycelial filaments, and rows of spores in ringworm crusts of calf. X310.

ARKANSAS DEMOCRAT CO.
PRINTERS AND BINDERS,
LITTLE ROCK.

HORTICULTURE.

GRAPES—Varieties best adapted to Arkansas.

STRAWBERRIES—Keeping Qualities, Varieties.

RASPBERRIES.

PLUMS.

ARKANSAS INDUSTRIAL UNIVERSITY

Agricultural Experiment Station,

FAYETTEVILLE, ARK.

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UNIVERSITY OF CALIFORNIA

GRAPES.

By J. F. McKay.

Until the last few years but little attention has been given to the culture of the vine in Arkansas. The industry is still in an undeveloped state and there is room for vast improvement. A few growers are scattered about in different localities, and where they have given attention to the subject have succeeded in producing as good fruit as is grown anywhere. We might say, they have solved the problem as to whether or not grape growing is a success in Arkansas. The question of first importance seems to be, what varieties do we want to start with? It will require time and continued study to give an intelligent reply. Varieties will sometimes do well for a season or two then fail. Notably the Concord and the *Labrusca* varieties generally. More discouragements have come from this cause perhaps than any other.

It has long ago been determined by many experimenters that the class of fruit grown in California and arid regions of the West, which is principally European stock, cannot be grown with profit in Eastern and Central States. We must turn our attention to the development of our native species as we can look for nothing but failure from the foreign strain or (Vitis Vinifera.) The American grape has already been developed to a very high degree of excellence. From the four principal native species a great number of valuable seedlings,* crosses and hybrids have been obtained.

In order to determine varieties that would resist black rot and mildew best, no spraying was done to prevent these dis-

eases. It has been conclusively shown alike by experimenters in this country and Europe, that these two very destructive fungus diseases can be largely controlled by judiciously spraying the fruit and vine with the Bordeaux mixture, which is a solution of sulphate of copper (blue stone), and lime. Blue stone is considered harmless, as it requires several grains to produce an injurious effect on men.

Out of 140 varieties untreated, at least three-fourths proved from worthless to poor this season. Have selected about 25 varieties that have proved more or less valuable here and as far as can determine, best adapted to other portions of the State. The only varieties that proved entirely free from disease were of the *Æstivalis* (Southern summer grape) strain.

VARIETIES.

The American cultivated varieties have been mainly obtained from four native wild species:

Vitis Labrusca—(Fox grape.)

V. Æstivalis—(Summer grape of the South.)

V. Riparia.

V. Cordifolia—(Muscadines.)

For study we group them by species as below.

VITIS ÆSTIVALIS.

This species is found growing in woods of Arkansas and generally throughout Southern and Central States. Vines are vigorous, rapid growers, little subject to disease or insect injuries; bunches compact; fruit from medium to small, no pulp, juicy and sweet when fully ripe. Varieties from this species are pre-eminently the grapes for Arkansas, and about the only ones we can expect to grow with any degree of success without continued spraying. These grapes have won the foremost rank as wine producers, and are coming into prominence

for home and market. The only objection is the size. As they produce more wood than the *Labruscas*, should be given more space. We cannot urge too strongly the value of this home species to Arkansas vineyardists. Varieties are few. We recommend the following:

Cynthiana.—(Also known as Arkansas and Red River.) This is an Arkansas variety, blue-black, bunches very compact, berries medium size; no pulps, sweet and flavory; very prolific. September. This and Norton are considered by many as the best grapes we have for red wines.

Norton's Virginia.—This resembles the Cynthiana so closely that they can scarcely be distinguished one from the other. Cynthiana bunches more shouldered, fruit little sweeter. Both vines are rapid growers, free from any disease. Fruit colors early, but will grow better and hang on till October. They can be relied on for an abundant crop when others fail.

Herbemont.—Consider this the most delicious table grape we have grown here. It is very prolific. Bunches very large; berries small but all juice; sub acid, excellent flavor. Ripe last of September. Grows rapidly, makes a coarse, strong vine, almost free from disease of any kind. Recommend it as the best late grape we have tested for home vineyard. Munson thinks it originated from some European species closely allied to Æstivalis but not identical with it.

Eumelan.—A chance seedling, generally considered of this family, but has some marks of a foreign strain. It ripens very early. Medium size; black berries; tender, melting flesh; produces well; a little subject to rot; strong vine. Valuable for early.

Cunningham.—Very similar to, and probably a seedling of Herbemont. Prolific; excellent fruit; little larger than the parent; bunches smaller.

VITIS LABRUSCA—(FOX GRAPE.)

Home of this species is in North and Central Atlantic States. It has been longer in cultivation than any other native

species, and the greatest number of our market varieties are its offspring. Grapes are larger and more showy than *Æstivalis*. Tough pulp, foxy or musky taste, which render them less valuable for wine. The long list of varieties obtained from this stock vary greatly in size, color, taste and habits generally. None of the *Labrusca* or its hybrids will withstand rot and mildew as will the pure Æstivalis, nor are they as hardy growers. They cannot be grown without systematic poisoning for these diseases. May obtain a few splendid crops, but the experience has generally been that unless they receive the very best attention, will become so diseased after three or four seasons as to necessitate new planting. But we cannot yet discard them, as they hold the principal places in the market. The most successful varieties tested are given below, as near as possible, in order of ripening.

Moore's Early. — Black, seedling of Concord, bunches smaller, berries same size, sweeter; prolific; strong vine. One of the best for early. With good treatment, think it will do well.

Hartford.—Black; an old, early variety; good when you can grow it. Rots badly, and is not to be trusted.

Cottage.—Black, seedling of Concord. This season was the best early variety we had in quality and quantity. Large bunches; medium berries; very sweet, with little or no foxiness; two weeks earlier than Concord.

Early Victor.—Black; medium bunch and berry; early; fair variety.

Woodruff.—Red, large grape; very prolific; little rot or mildew; quality fair; foxy.

Wyoming.—Red; a handsome fox grape; vine very hardy and prolific. Juicy, sweet, but foxy.

Perkins.—One of the best red market varieties for this country that we have; prolific and healthy; prefer it to the two above.

Niagara.—White; very popular market grape; not the best to eat; produces fairly well here; vine only medium grower.

Ives' Seedling.—Black; bunches medium and compact; berry showy; thick skin and pulpy. The most prolific and healthy of this family; resists rot and mildew almost as well as Norton. Reliable market grape.

Eaton.—Black; seedling of Concord; very large and showy bunches and berries; about double the fruit of Concord; ten days later; vine strong and healthy so far. If it holds out as it starts, will be a most valuable variety for home or market. Try it.

CROSSES AND HYBRIDS.

Delaware.—Hybrid between *Labrusca* and *Vinefera*. It is too well known to need a description. In point of excellence, heads the list of hybrids. Vines are very tender here, and need careful attention. When properly treated can be relied on for a good crop of best fruit. Vines will bear planting close together; medium early.

Brilliant.—Munson's cross from Delaware as one parent; equal to it in flavor, and otherwise very much same fruit. Vine seems stronger, less disease. Promising to take place of Delaware. Have not given it sufficient test here.

August Giant.—Black; large; splendid flavor; little mildew or rot; fine grower and bearer; good variety.

Agawam.—Red; one of Rogers' hybrids; fairly successful here, but inclined to mildew.

Bacchus—(Riparia.)—Bunches compact; berries small; no pulp; very prolific; as free from mildew as Norton; too small for market; considered valuable for wine.

Berckman's.—Very much like Delaware but larger; few days earlier this season; vines are stronger; less mildew.

Missouri Riesling.—Pale red; medium bunch and berry; tender and sweet. Very healthy, good bearer.

Have a number of Rogers' and Munson's new seedlings and hybrids; none have shown any strikingly valuable qualities yet.

CORDIFOLIO—(MUSCADINES.)

Flowers, *Scuppernong*, *Thomas*, and some other varieties of this species planted, are all growing vigorously; no disease. This seems to be the home of these hardy vines. Not old enough to bear yet. These varieties should be given plenty of space to grow as they make an enormous growth. They are valuable for arbors and home gardens.

The following list, given in order of ripening, cover the season very nearly, are recommended as best we have tested, and, so far as can determine, are successful throughout the State where they have been tried.

Moore's Early.
Cottage.
Eumelan.
Delaware, or Brilliant.
Perkins.
Ives.
Concord.
Eaton.
Cynthiana, or Norton.
Cunningham.
Herbemont.

Information in regard to application of poisons for insects and fungus diseases will be cheerfully given by the Station to those desiring the same.

STRAWBERRIES.

The markets are flooded every year with new varieties of Strawberries. A few are improvements on the old, many are not. While we encourage and advise private experiments, yet it is the aim of the Station to save the growers as much of this expense as possible. This plant has a very broad range. By comparing carefully, the reports from many sections of the country, results obtained from some varieties are found to correspond very closely. So careful work done at the Experiment Station can usually be trusted by growers in other parts of the State.

It is the general opinion of cultivators, that a variety will "run out" when propagated from runners for a number of years, and that they must look to the introduction of new seedlings. It is certainly a fact, that with the ordinary treatment and common practice of taking the plants for new planting indiscriminately from old fruit beds, they will deteriorate. The rapidity with which they decline will depend largely on the treatment they receive. While it seems that with Strawberries and also other fruits, when propagated solely from division, the stock will gradually grow weaker, yet it is not proved that it will do so under all conditions. The experience of many experimenters go far towards demonstrating that if Strawberries are cultivated with a special view to produce strong, healthy plants and carefully selecting the same, there is little or no variation from year to year. But it is an undeniable fact that there are some old varieties in the South that were once the very best which have from some cause or other, become worthless, and must be discarded.

We have often been asked to suggest Staminate or perfect blooming varieties that could, themselves, be grown with profit and as pollen producers for imperfect or Pistillates. We found in some places varieties planted that were worthless as producers, and cultivated simply to fertilize blooms of others. One cannot afford to grow two plants, and gather fruit only from one.

Nor can we discard the Pistillates because of its imperfection, for it is a notable fact, and we could not expect otherwise, that they are more prolific than those that develop both sexual organs.

The work herein reported was done mainly with these two questions in view:

1. Comparative keeping qualities of varieties.
2. Best Staminates for fruit and as fertilizers.

We have about 80 varieties on Station grounds planted in spring of '90. This season, as they had not started out, no blooms were killed by late frosts. Conditions were as near alike

as possible; season very favorable. They all had an even start and an equal show. The early fruit in vicinity of Van Buren, Judsonia and Little Rock was killed by the heavy frosts of April 5th and 6th. Little fruit was out in this locality, no damage was done. So the season here was only a few days later than in southern and lower parts of the State.

The accompanying table gives the results of several tests made at different times during the season, with a view of determining how long the various varieties will keep sound after gathering. Full colored sound fruit of each variety was selected at same time, placed in a room at ordinary temperature ranging from 60° to 80°, packages covered, leaving slight ventilation. These figures give the average of the several tests.

TABLE SHOWING COMPARATIVE TIME OF KEEPING.

PER CENT OF SOUND AND SALABLE FRUIT AFTER	1 Day.	2 Days.	3 Days.	4 Days.	5 Days.	6 Days.	7 Days.
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Atlantic S.	No change worthy of note in any variety during first 24 hours, if sound to start with.	all	all	.90	.75	.50	.20
Bubach P.		all	.95	.80	.70	.30	.10
Ueder Wood, S.		all	all	.95	.85	.50	.15
Banquet		all	all	.90	.65	.20	.00
Crescent, P.		all	all	.95	.80	.40	.5
Crystal City, S.		.95	.75	.50	.25	.00	.00
Charleston, S.		all	all	all	all	.90	.75
Cloud's Seedling, P.		all	all	all	.90	.75	.40
Crawford, S.		all	all	all	all	.85	.60
Capt. Jack, S.		.90	.90	.85	.65	.20	.00
Charles Downing, S.		.90	.75	.60	.30	.00	.00
Cumberlain, S.		all	.85	.70	.40	.20	.00
Eureka, P.		all	.90	.80	.60	.20	.00
Hoffman, S.		all	all	all	all	.90	.75
Haverland, P.		all	.95	.85	.60	.25	.00
Jersey Queen, P.		all	.85	.70	.60	.10	.00
Jessie, S.		all	.95	.80	.65	.20	.00
Kentucky, S.		.90	.75	.60	.30	.00	.00
Michel's Early, S.		all	all	.90	.75	.50	.15
May King, S.		.95	.80	.60	.30	.00	.00
Parker Earle, S.		all	.95	.85	.50	.30	.00
Stayman's, No. 1, P.		all	all	.90	.75	.40	.10
Stayman's, No. 2, P.		all	all	.95	.80	.40	.10
Warfield, No. 2, P.		all	all	.90	.75	.50	.10
Wilson, S.		all	all	all	.85	.70	.40
Windsor Chief, P.		.95	.75	.50	.30	.00	.00
Van Deman, S.		all	all	.95	.80	.50	.20

Assuming in the main the correctness of these figures, we see that under ordinary atmospheric conditions, by careful handling and selection of firmest fruit, it is marketable only from four to five days at most. As commonly handled, they will perish much sooner than this. Thus the necessity of selecting the firmest kinds and exercising the greatest possible care in marketing this very perishable fruit.

By comparing the tests of first half of season with those of later half, it is found that the first fruit kept fully twenty-four hours longer. In this case, some of the late fruit was finer, richer, looked better generally, temperature about the same, yet they perished in much shorter time.

CONDITIONS OF KEEPING.

Packages ranging from air-tight to full exposure were tried. When sealed air-tight the fruit moulded in a short time. Full exposure to air and light berries darkened and perished rapidly. Best results were obtained where the fruit was closed up with just enough ventilation to allow slight circulation. The crates ordinarily used for shipping, closed up well at the top, will allow plenty of ventilation and keep out dust. Where refrigerator cars are used, small space might be left to advantage on the sides, at the top of crate, to allow the ready escape of warm air.

PERFECT BLOOMERS VS. IMPERFECT.

From comparison of twelve best Staminate or perfect varieties with an equal number of Pistillates, found

1st. That Pistillates nearly double Staminates in productiveness.

2nd. Pistillates, as a rule, are hardier and freer from rust.

3rd. The Staminates average little larger, are more uniform and better developed.

4th. Staminates are firmer and better average keepers.

NOTES ON SEVENTEEN OF THE MOST PROMISING VARIETIES.

Bubach No. 5 (P.)—The largest average berry we have; bright, showy, a little soft, but firm as Crescent. Plants large and healthy; produced a very large crop. The best berry for local market or home.

Warfield No. 2 (P.)—A new variety, promising to lead as a market variety; early; good size; dark color; firm; very prolific; makes plenty of strong plants.

Haverland (P.)—Taking the whole season through, led all others as a producer; large; good flavor; ripens with Crescent; in firmness about the same; ahead of it in other points, and promises to take the place of this old standard.

Cloud's Seedling (P.)—This is a popular Southern berry, extensively grown; has lost somewhat in favor. When it strikes a good season, no variety can beat it for early market. This season it made more early, firm fruit than any variety we have. Medium size. Plants vigorous, but little inclined to rust.

Crescent (P.)—Has for years been one of the most extensively grown and generally successful varieties; is now giving away for newer kinds that are larger, firmer and better flavored. Produced only fairly well here; plants small but healthy.

Crystal City (S.)—First to ripen; considerably grown in some parts of State; soft and small; consider it worthless here.

Stayman's Nos. 1 and 2 (P.)—Introduced by Dr. J. Stayman, of Kansas. Medium size; firm; perfectly formed berry; bears heavily all through the season; fine quality; fruit, after ripe, will keep firm on vines several days. Large, strong plants. The two are so near alike, description will answer for both. Consider them quite valuable.

Eureka (P.)—Produces good crop of large, showy berries. A little soft, late.

Bessie (P.)—Promises well; early; good size and firm; plants were young; can't give full report.

May King (S.)—A few early berries; poor this season.

Beder Wood (S.)—Originator, Beder Wood, Moline, Ill. Very prolific; fruit firm; bright plants; very large; have a tendency to stool. Holds up its fruit well. New variety of promise as a pollen producer.

Crawford (S.)—From a number of tests was found to be the best keeper and most suitable large berry we have for shipping long distances. In size, second to none but Bubach. Plants hardy; medium early. Consider it a most valuable kind for its good yield of firm fruit, and as a fertilizer for Pistillates.

Michel's Early (*S.*)—Originated at Judsonia, Ark. Has been experimented with extensively, and has generally given satisfaction. Makes a great show of early blossoms; is a good pollen producer for early varieties. Fruit very early, large, pale, irregular, little soft. Produced fairly well this season, but not equal to Pistillates. A most vigorous grower, shows a little tendency to rust.

Captain Jack (S.)—This has been largely used as a fertilizer; produces a good crop of small fruit; seems to hold up well, but think we have better varieties to take its place.

Van Deman (S.)—Introduced by Jack C. Bauer, Judsonia, Ark. Promising new variety; sound, fair size fruit; plenty of blossoms; not sufficiently tested here to report further; seems successful elsewhere.

Hoffman (S.)—Produces early and late; large, very firm, perfectly formed berries; one of the most thoroughly reliable Staminates grown in the South for fruit or fertilizing others.

Gandy's Pride (S.)—Very large, late variety. Fruit plentiful, firm, highly flavored; valuable for late market.

Recommend the following list to Arkansas growers:

SIX BEST PISTILLATES.	SIX BEST STAMINATES.
Bubach No. 5.	Crawford.
Warfield No. 2.	Hoffman.
Haveland.	Michel's Early.
Stayman's Nos. 1 or 2.	Beder Wood.
Cloud's Seedling.	Van Deman.
Crescent.	Captain Jack.

Varieties that were failures, as far as this locality and season's trial are concerned:

Charles Downing.	*Monarch.*
Wilson.	*Cumberlain.*
Jessie.	*Kentucky.*
Sharpless.	*Old Iron Clad.*
May King.	

RASPBERRIES.

Unfortunately have very few varieties of Raspberries in bearing. Season was favorable; those we have, yielded well.

Marlboro's.—Red; very large and prolific; fruit showy, keeps well, early; extra for market.

Turner.—Red; old variety; makes a fair yield; good quality but little soft; Marlboro or Hansell better producers.

Cuthbert.—Red; firm, fair size berry; valuable late variety; vines little unhealthy.

Hansell.—Red; earlier than Cuthbert; as far as tested, appears healthy and prolific.

Schaffer's Hybrid.—Large purple fruit; heavy vine; made very little fruit.

Gregg.—Black; medium size, prolific, valuable variety; plants strong.

Ohio.—Black. This is one of the best varieties of the blacks for market or home; earlier than Gregg; some larger.

Royal Church.—Red; a promising new variety from Ohio; grows well; plants young; have not tried it sufficiently to give an opinion.

Marlboro, Hansell, Ohio and *Gregg* considered best on our list.

PLUMS.

Have quite a list of plums on the Experiment Station grounds. Many are young and have not fruited yet.

Botankio, Kelsey, Ogon and Botan, Japanese varieties; planted in 1888. They all set some fruit this season, but none developed; suffered more from attack of curculio than native varieties.

European Plums.—The only trouble in raising these fine table plums here seems to be the curculio. If we can get rid of it by use of poisons, I believe we can equal any country in the production of this fruit. Trees are healthy and make a splendid growth. A tree of the *Shropshire Damson* in a neighboring orchard, produced several bunches of very best plums, that brought $1.75 per bushel in Kansas City market.

Russian No. 3, developed some good fruit.

Bavay's Green Gage made a splendid yield. Curculio made his scar, but healed over very well.

Wild Goose.—From the native *Prunus Chicasa* stock. Produced a heavy crop of splendid fruit trees averaged about three bushels each. Did not seem to be injured in the least by curculio. Should be grafted or budded. When on its own root produces too many suckers. Fruit always finds a ready market. Ripens in July.

Desota.—Made a heavy yield of fair size yellow plums; more delicate flavor than Wild Goose. Free, healthy.

Maquoketa.—A new variety orignated in Iowa. Planted in spring of '88. Made a very large crop second year after planting. This season's yield was very large; showy red delicious fruit; month later than Wild Goose; withstands the cur-

culio perfectly. Consider it the most valuable native variety in our orchard.

Blackman.—Makes a beautiful tree; produces no fruit. Have observed it in several orchards and learn it has never fruited, although we have trees five or six years old.

LE CONTE AND KEIFFER PEARS.

Pear orchards have so often been swept away by the disease known as "blight," that it has become a question with Horticulturists if they can afford to plant large orchards of this fruit. As a consequence, supply is limited and prices generally high for good fall pears.

When Le Conte was introduced under the claim of being "blight proof" it was planted far and wide over the country. Experience has shown that it suffers almost as much from blight as the Bartlett and has other bad habits. In an orchard planted one-half in Keiffers, one-half in Le Contes that are now five or six years old, Le Contes have started out too early and have been killed past two seasons. The Keiffers were unharmed, made splendid yields of large showy fruit that will keep well into the winter months. Fruit is good when well ripe and will always sell. There is less blight on the Keiffers than on the Le Contes. Trees are healthy; commence bearing early after planting. Think this variety is going to prove valuable to Arkansas growers. Le Contes have failed so far to give satisfaction.

AGRICULTURAL
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FOURTH ANNUAL REPORT

OF THE

Agricultural Experiment Station

AT THE

ARKANSAS INDUSTRIAL UNIVERSITY,

FAYETTEVILLE ARKANSAS.

February 1, 1892.

LITTLE ROCK:
ARKANSAS DEMOCRAT CO., PRINTERS.
1892.

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1892.

AGRICULTURAL EXPERIMENT STATION,
FAYETTEVILLE, ARK., Feb. 1, 1892.

To His Excellency, JAMES P. EAGLE,
Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Fourth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

R. L. BENNETT,
Director.

BOARD OF TRUSTEES.

His Excellency, JAMES P. EAGLE, President.

HON. W. B. WELCH, M. D.,

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R. L. BENNETT, - - *Director and Agriculturist.*
G. L. TELLER,* - - - - - - *Chemist.*
R. R. DINWIDDIE, - - - - *Veterinarian.*
J. T. STINSON, - - - - *Horticulturist.*
C. L. NEWMAN, - *Assistant Agriculturist at Pine Bluff.*
GEO. B. IRBY, - *Assistant Agriculturist at Newport.*
F. W. KILLEN, - - - - *Assistant Chemist.*

*Prof. Teller records Meterological Observations.

FINANCIAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

OF THE

INDUSTRIAL UNIVERSITY OF ARKANSAS.

In Account with the United States Appropriation.

1891.	DR.		
To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30th, 1891, - - - -			$15,000.00
1891. JUNE 30TH	CR.		
By Salaries, - - -		$8,006.87	
By Labor, - - -		1,013.25	
By Sundries, - - -		674.55	
By Technical Apparatus, -		289.88	
By Chemicals, - - -		311.49	
By Seeds and Trees, - -		184.26	
By Library, - - -		17.90	
By Implements, Machinery and repairs for the same, -		52.35	
By Feed, - - -		1,274.46	
By Freight and Express, -		161.30	
By Newport Station, -		1,878.06	
By Pine Bluff Station, -		967.57	
By Stock, - - -		209.36	
By Printing, - - -		249.20	
By Travel, - - -		422.31	
			$15,712.81
Excess of Expenditures over Receipts, -			$ 712.81

The foregoing Statement is taken from the books of the Experiment Station.

R. L. BENNETT,

Director.

REPORT OF DIRECTOR AND AGRICULTURIST.

R. L. BENNETT.

Experiments and other work of the Experiment Station suffered very much during the fiscal year by the many changes that took place in the station staff at different times throughout the year. At its close there remained only two members of the full staff at the beginning. Other men were appointed as fast as possible to fill the vacancies, but notwithstanding, the progress of the work was interrupted a great deal and much of the work begun was never completed while the lateness of the season prevented to a large extent those who came from beginning new work, therefore, as might be expected, the amount of work completed during the year is not very extensive, however, some good work was accomplished.

I entered upon the duties of director the 6th of July, 1891, at the close of this fiscal year, hence the operations covered by this report antedate my appointment as director. The third annual report for 1890 was not arranged for print until in the spring of 1891, when all data of experiments were collected and published in the third report as a matter of economy. Part of the experiments so included would have been the material for bulletins for this year, and a brief resume is given of the same under the departments in the succeeding pages. The third report was distributed to the general public.

AGRICULTURAL DEPARTMENT.

A feeding experiment with steers was conducted, the chief object of which was to determine the effects, if any, of cotton seed products variously combined upon the flesh and fat when used for fattening purposes. The rations were the same throughout the trial and their relative feeding values with their cost per pound gain were determined. There were not detected through the usual manner of manipulating beef any detrimental effects from feeding cotton seed products. Other work, begun at an earlier date, was completed with grass, sweet potatoes, field peas, etc.

VETERINARIAN'S REPORT.

R. L. BENNETT:

Sir—The following is a synopsis of the work done during the past fiscal year in the Veterinary Department of the Experiment Station:

During the summer my time was occupied with field and laboratory studies of the disease of cattle known as Southern or Acclimating Fever. These were conducted chiefly at Little Rock, but also at Helena and Fayetteville.

Tests were made of various substances supposed to be concerned in the causation and spread of this disease.

The results of the tests of preventive inoculation, begun in the previous year, were also noted.

I have also made an effort to determine the extent of infection of pastures, and the annual amount of loss to cattle owners in the State from this cause. On these last questions sufficient data has not yet been obtained to warrant its publication.

The details of the investigations above referred to are included in the third annual report of this Station. (Veterinarian's report.)

An investigation was also undertaken and completed of a skin disease of cattle of extensive occurrence in this State, commonly known as "White Scab."

I succeeded in proving its contagious nature and established its identity with Ringworm. Its nature, treatment and prevention are detailed in Bulletin No. 16 of this Station.

Besides attending to a considerable correspondence on diseases of live stock in the State, of more or less importance, I have, when called upon, and when the occasion seemed to require it, visited the localities where outbreaks of contagious or infectious animal diseases prevailed and advised the necessary measures to be adopted for their suppression.

Respectfully,

R. R. DINWIDDIE.

DIRECTOR OF THE ARKANSAS AGRICULTURAL EXPERIMENT STATION:

Sir—Upon taking charge of the work here, the 20th day of September, 1890, there were turned over to me by Prof. C. B. Collingwood the results of the analysis of a large number of grasses and such of the work on sorghum as had been done up to that date. A brief report of the work of the department up to July 1, 1891, is given below.

Respectfully, GEO. L. TELLER.

ANALYSIS OF GRASSES.

This work was undertaken and performed by Prof. Collingwood and Mr. G. A. Humphreys. It consists of the analysis of about thirty specimens of Arkansas grasses, of different varieties and at different stages of growth. Believing that the purpose of the Station can be best served by publishing the results in connection with other work, they will be reserved for a future bulletin, in which they will be printed in full, with due credit to the parties who did the work.

SORGHUM AND SUGAR BEETS.

The work on sorghum comprises the complete analysis of 352 samples of juice and a partial analysis of 225 others. It was begun and about one-third completed under the directions of Prof. Collingwood. It may be divided under three heads:

1. *The Effect of Fertilizers upon per cent of Sucrose or Cane Sugar.*—To study this point, forty plots, comprising one-fiftieth of an acre each, were planted with seed of Early Orange Sorghum. Three of the plots were left without fer-

tilizers. The remainder of the plots were treated with different amounts of one or all of the following: Kainit, acid phosphate and cotton seed meal. These were scattered broadcast over the plots immediately after planting the seed.

The work of analysis, beginning September 3rd, was carried on after the canes were ripe. Seven complete series of analyses were made. The indications from this work, and from similar work carried on during the previous year, are strongly in favor of the conclusion: *That the application of kainit had a beneficial influence upon the amount of sugar in the canes and juice.*

2. *Comparison of Different Varieties of Sorghum.*—Eighteen plots were planted with different varieties of seed sent from Washington. Four series of analyses were made of the juice of these canes. The average polarization of the juice from each variety was more than fourteen per cent of sugar. Of the six varieties, the juice of which showed more than fifteen per cent of sugar, all but one were said to be crosses. The same varieties show a relatively high purity co-efficient.

3. *Analyses of Juices as an Index to the Selection of Seed.*—For this purpose partial analyses were made of the juices from 227 single canes. The object in view was to select, for planting, seed from those canes richest in sugar. By so doing, it is hoped to secure, in time, canes of a better quality than those we have at present.

Sugar Beets.—During the summer of 1890, there were grown upon the University farm thirty plots of beets of one-fiftieth acre each. The soil is a somewhat heavy clay loam with clay subsoil. The plots grew fourteen different varieties. The Imperial Sugar Beet was grown on several plots, with and without fertilizers. In October the beets were dug, topped, weighed and samples selected for analysis. In only one case was the amount of sugar in the juice found to be

above nine per cent, whereas, the same varieties of beets grown in other localities frequently yielded a juice polarizing from fourteen to eighteen per cent. The White Imperial variety yielded a juice polarizing 11.8 per cent of sucrose.

OTHER CHEMICAL WORK COMPLETED.

The tubers of nine different varieties of sweet potatoes, grown at Newport in 1890, were analyzed as were also the vines of two of them. During the winter the milk of two cows, spayed a year before, were analyzed night and morning for a week. Analyses were made of nine samples of feed used in the feeding experiment at Newport. The melting points were also determined of the tallows of the eleven animals fed in the same experiment. Analyses were also made of six samples of fertilizers and some other miscellaneous matter.

Detailed results of most of the above work have been published in connection with the third annual report of this Station.

In addition to the above work, a considerable time has been spent in the study of methods of analysis in co-operation with committees of the Association of Official Agricultural Chemists.

WORK IN PROGRESS.

Believing that a continuous record of the weather is important in connection with much of the work of the Station and a matter of interest generally, a set of instruments has been secured, a suitable shelter erected, and observations are now taken three times daily upon the precipitation, humidity, temperature, wind, clouds, etc. Monthly returns are made to the Chief of the State Weather Bureau at Little Rock, and a copy of the record kept on file for future reference, and, perhaps, publication.

The other work now in progress, under charge of the department, may be summarized under the following heads:

1. A further study of the improvement of sorghum by the selection of seed.

2. Relative composition of sweet potatoes grown from the same seed at Fayetteville, Newport and Pine Bluff, with special reference to their sugar contents.

3. Pot experiments to study certain problems connected with the relation of nitrogen to growing plants.

4. Plot experiments to study the relative fertilizing and feeding value of cow peas at different stages of growth.

It is expected that detailed plans of such of these experiments as results seem to warrant will be published in due time.

BOARD OF TRUSTEES.

His Excellency. JAMES P. EAGLE, President.

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J. L. CRAVENS, Secretary and Treasurer.

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AGRICULTURAL EXPERIMENT STATION,
FAYETTEVILLE, ARK., July 1, 1892.

To his Excellency, JAMES P. EAGLE,
Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Fifth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

R. L. BENNETT,
Director.

SOME COTTON EXPERIMENTS

—AT—

NEWPORT.

AGRICULTURAL EXPERIMENT STATION

—AT—

ARKANSAS INDUSTRIAL UNIVERSITY,

FAYETTEVILLE, ARK.

BULLETIN No. 18.

February, 1892.

THE BULLETINS OF THE STATION ARE SENT FREE TO ALL RESIDENTS OF THE STATE WHO REQUEST THEM.

LITTLE ROCK, ARK.:
ARKANSAS DEMOCRAT CO., PRINTERS,
1892.

ARKANSAS INDUSTRIAL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

HON. J. T. HENDERSON. HON. W. H. LANGFORD. HON. B. C. BLACK.

THE PRESIDENT OF THE UNIVERSITY. THE DIRECTOR OF THE STATION.

STATION OFFICERS.

R. L. BENNETT..... Director and Agriculturist.

GEO. L. TELLER.....Chemist.

R. R. DINWIDDIE..... Veterinarian.

J. T. STINSON.....Horticulturist.

C. L. NEWMAN.....Assistant Agriculturist at Pine Bluff.

GEO. B. IRBY.....Assistant Agriculturist at Newport.

F. W. KILLEN.....Assistant Chemist.

SOME COTTON EXPERIMENTS

AT

NEWPORT.

R. L. BENNETT.

[NOTE.—The cotton experiments and notes contained in this Bulletin were completed last year and are only a small part of experiments being conducted with cotton, the results of which will be published this winter after repeating the experiments this year. The yield of the experiments given herein are small, due to the late planting and the unfavorableness of the early season.]

COTTON SEED FOR FERTILIZING VERSUS SELLING SEED.

This is an exceedingly important question to farmers and one which very few have ever considered. What a farmer receives for his seed depends upon his location and accessibility to market. At small towns, or towns without oil mills, the price paid for seed is about $6.50 per ton delivered and frequently less. Now, the experiment was planned to ascertain if it is not more profitable to use the seed as a fertilizer than to sell them delivered at $6.50 per ton in the market. So 500 pounds of seed were bought and rotted, then applied on one acre in the drill at the time of preparing the soil for cotton; another acre was treated similarly in every respect without an application of seed, the results are shown in the subjoined table.

PLOTS.	APPLICATION.	Cost of Seed at ~~$—.—~~ per Ton. $6.50	YIELD.	INCREASE.	Value of Increase at 6 cents per pound.	PROFIT.
1	500 seed	$1.62	949	250	$5.55	$3.93
2	Nothing		699			

From the use of the 500 pounds of seed per acre, costing $1.62 at the rate of $6.50 per ton, the profit is $3.93.

or, in other words, if a ton of seed costing $6.50 had been applied to four acres at 500 pounds per acre the profit would have been $15.72, that is, the increase in yield of cotton on the four acres would have been sufficient to pay $6.50 per ton for the seed and a profit remaining of $15.72. The above experiment may be relied upon as correct as it was checked by another. It is reasonable to suppose the full fertilizing value of the seed was not consumed by this crop, so its influence may be felt another year. That will be ascertained this year. The two plats will be planted to cotton again without fertilizing with seed. From the experiment, any farmer that grows cotton and sells his seed, and if his land is not too rich already, may estimate his loss. The fertilizing value of cotton seed is admitted by every one; they are equally good for corn as cotton, wheat, oats, etc. A few soils may not produce the increase shown by this experiment, while others will produce more. The Station soil is a sandy loam with a poor sub-soil of yellow clay. The valuable fertilizing ingredients, Acid Phosphate, Potash and Nitrogen, when estimated by the Commercial fertilizer tariff as other fertilizers, a ton of seed is worth about $15.00, or, if those ingredients were bought in the market in the same quantity as they exist in a ton of seed, they would cost $15.00, so if farmers could receive more than $15.00 a ton for their cotton seed they could then afford to sell them and buy a good Commercial fertilizer to replace the plant food removed in the seed.

COTTON SEED AS A FERTILIZER VERSUS COTTON SEED MEAL WHEN COST IS CONSIDERED.

Farmers are advised to sell their cotton seed and buy cotton seed meal for fertilizing, and as a farmer's location and accessibility to oil mills determine the price of his seed as well as the meal, it would be folly for him to do so, only in exceptional cases, so long as the disparity that now exists between the price of seed and cotton meal. The oil contained in the seed is of no value as a fertilizer. The average market price of seed per ton delivered in Newport at the railroad is $6.50, and the same at other similarly situated

points, while meal is worth $20.00 per ton. To ascertain the corresponding results by using the two as a fertilizer on cotton, an experiment was planned; three similar plats were selected and seed applied to one and meal to the other, both at the rate of five hundred pounds to the acre; the treatment of the three plats was similar in all other respects. The subjoined table shows results and requires no explanation:

Plots.	Cost.	Amount Cotton Produced per acre.	Increase.	Value of Increase of Cotton 6 cents per Pound.	Profit.
500 C. S. meal.	$5.00	1199	400	$8.90	$3.90
500 Cotton seed.	$1.62	949	250	$5.55	$3.93

In the event the profit from the use of cotton meal had slightly exceeded the profit from the seed, farmers can afford to buy cotton seed for fertilizing when they cannot buy cotton seed meal, because of the difference in the cost of the two. If the two were applied to soil at the same rate as in the experiment, it would cost $1.62 per acre for seed, and $5.00 per acre for meal, or to make the difference more apparent, to fertilize fifty acres with seed at the rate of five hundred pounds per acre, the cost would be $81.00. The meal for fifty acres would cost $250.

ROTATION EXPERIMENT.

A system of rotation was begun at Newport to ascertain if the worn cotton and corn land could not be improved without the use of any kind of manures, and at the same time yield a profit. The plants used in the experiment are cotton, corn field peas and barley. This is the second year of the rotation, and the results of both years are given as follows:

FIRST YEAR, ACRE PLATS.

No. Plats.	Kind of Plants and Method of Treatment.	Net Profits.
1	Cotton	$ 8.00
2	Field peas; value peas picked, pea-vines turned under and barley sown in fall	$30.00
3	Field peas, peas picked, value of pea-vines allowed to remain on soil through winter	$30.00

SECOND YEAR.

1	Cotton	$ 5.96
2*	Barley, cut 1,500 pounds, value $5.00. Planted in cotton	
3	Cotton	$11.25

* Omitted because of error.

By a study of the table it will be seen that in the first year there was no loss by growing peas for sale, as compared with cotton valued at eight cents for both years. Peas command a high price for planting purposes, though they would have yielded a profit equal to the cotton if they had been sold for half the price, and at that price they would have been cheaper and better than corn for stock.

In the second year the soil was so much increased in fertility where peas were grown, plat 3, as to almost double the yield of plat 1, where cotton had grown two years. The experiment will be continued and results reported from time to time. Thus far the experiment is valuable in showing that soils can be improved without manures, and without any diminution of profits. It further demonstrates the value of the field pea as a farm plant. It is, in fact, valuable as a fertilizer for all crops.

SOIL ANALYSIS WITH FERTILIZERS.

This experiment was performed in part and is given below. The object of such experiments is to determine the needs of soils, and affords interesting study of the effects of fertilizers. This method is the only practically reliable one to determine the needs of soils and can be done on every farm

by every farmer at an exceedingly small cost and should be done whenever Commercial fertilizers are to be used. Experience as well as experiment has demonstrated that soils vary in their capacity to supply plant food, soils are deficient in different ingredients of plant food, and the manner of determining what ingredients are deficient and what are abundant is by asking the soil the question by applying certain fertilizers and getting the reply in the crops produced. Fertilizers are applied to soils to supply plant food. The ingredients that are usually necessary to supply to soils and which are less abundant than others, are Potash, Nitrogen, Phosphoric Acid, Lime and Sulphuric Acid. The first three are the most important ingredients of our Commercial fertilizers, the latter two are usually supplied as Land plaster or Gypsum. Plants vary greatly in their capacity to procure plant food from the soil, therefore the fertilizers to be used will depend upon the plant and the experiment will suffice only for that plant and that soil. The experiment should be repeated; one year will not be exactly sufficient to determine perfectly reliable results. Before purchasing Commercial fertilizers the natural resources of the soil should be developed to their fullest extent. Sometimes soils contain an abundant supply of plant food and still fail to produce good crops because of the need of proper tillage and treatment. Fertilizers, particularly Plaster, exert a beneficial effect indirectly on some soils by improving its mechanical condition and not by the direct supply of additional plant food. Only when all the manures on the farm are insufficient to supply the crops with plant food should Commercial fertilizers be bought and then it becomes essential to know what fertilizers are needed on a certain soil for a certain crop, hence the importance of the soil analysis with the fertilizers themselves. A soil may contain all three of the more important ingredients or only two or even one in sufficient or partially sufficient quantities in an available condition for the plants' use, therefore, in applying a fertilizer, it would be unwise to apply all the ingredients unless it is known that all are needed, only one might be necessary, so in supplying that one it should be procured in the cheapest and best form. In making soil tests

several precautions are to be carefully observed; first, the soil used must be of uniform fertility and a fair representative of the field, the piece should be laid off in plats of about $\frac{1}{20}$ acre each with a distance of 3 feet or more between, so as to prevent the plants in one plat from feeding on the fertilizers in the adjoining one. They should be rather short than too long and when laid off in rows each plat should have the same number. The product of the two outside rows should not be harvested nor estimated with that of the inside ones so as to avoid external influences. The same number of plants should be on each plat and evenly distributed over them. Extreme care must be observed in every detail throughout the experiment in planting, cultivating and in weighing the product or inaccurate results will be obtained. The following experiment will illustrate the question of soil test; it was conducted at Newport, partly for soil test and for another purpose. A complete plan of soil test is given subsequently. $\frac{1}{20}$ acre was the size of plats used and were computed to acres as shown in the table; the cotton was planted very late at an unfavorable season, hence the small amount produced per acre; many bolls failed to mature and open on the Potash plat and the plants on that plat retained their foliage and continued to grow until frost.

FERTILIZERS.	Pounds Fertilizers per acre.	Amount Seed Cotton produced per acre.
Nitrogen furnished by Cotton Seed Meal	500	1199
Potash furnished by Kainit	500	899
Acid Phosphate	500	832
Nothing		799

From the table it is seen that the Nitrogen as furnished by the Cotton Seed Meal produced an increase of 400 pounds. The 500 pounds of Cotton Seed Meal contained about 7 pounds of Potash and about 17 pounds of Acid Phosphate, so they might have partly aided conjointly the Nitrogen to produce the increase, though the increase exceeds so far the

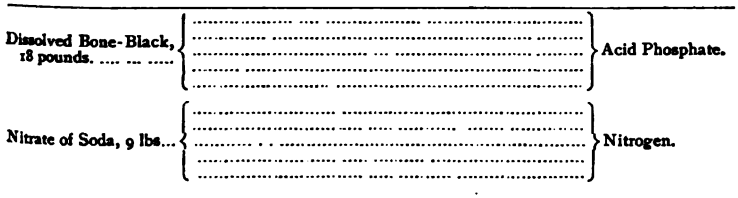
other two ingredients used alone that a conclusion that Nitrogen is the most necessary ingredient would not be far wrong.

The Cotton Seed Meal or Nitrogen application produced a considerable increase over the other two fertilizers, so a conclusion is reasonable that Nitrogen is more necessary for Cotton on the Station soil than either Potash or Acid Phosphate, or that the Station soil is more deficient in Nitrogen than Potash or Acid Phosphate, so far as Cotton is able to obtain it, under the cultivation and treatment given it.

As before noted, the productions are far short of what they should have been, hence the profit from the use of the Cotton Seed Meal is not so large as it would otherwise have been, while there is a loss from the use of Potash and a greater loss from the use of Acid Phosphate. If the Cotton could have been planted earlier the yield from the Potash plat would have been sufficiently better to have made a small profit. From the experiment, we might say for the Station soil for Cotton, an application of 500 pounds of Cotton Seed Meal and 100 pounds of Kainit would be a good fertilizer. Sometimes a combination of two or the three elements will make an increase, but when used singly, on the same soil, they will not.

The proper fertilizers to use in soil-tests are those that will furnish the ingredients singly and in as near a pure form as possible and their per cent known of the material sought, they can be had readily on the market.

Nitrate of Soda, containing sixteen per cent of Nitrogen; Super-Phosphate or dissolved Bone-Black, containing about sixteen per cent of Phosphoric Acid; Kainit, containing about fifteen per cent of Potash; Plaster or Gypsum of a high grade. They are applied to the plats singly, then two by two, and all three together, as indicated in the subjoined table, with the proper amounts to apply of each:



Kainit, 18 pounds	Potash.
Dissolved Bone-Black, 18 pounds Nitrate of Soda, 9 lbs.	Acid Phosphate. Nitrogen.
Dissolved Bone-Black, 18 pounds Kainit, 18 pounds	Acid Phosphate. Kainit.
Nitrate of Soda, 9 lbs. Kainit, 18 pounds	Nitrogen. Potash.
Dissolved Bone-Black, 18 pounds Nitrate of Soda, 9 lbs. Kainit, 18 pounds	Acid Phosphate. Potash. Nitrogen.
Plaster, 10 pounds	Plaster or Lime and Sul. Acid.
Nothing	Nothing.

COMPARATIVE VALUE OF VARIETIES.

There are many so-called varieties of cotton, and more are being added annually to the already extended list; some few have special merits of value, while a majority are conspicuous for their total absence. This latter point is clearly brought out in the results obtained by repeating the test with the same variety, though the same is more completely demonstrated when the results of tests of the same varieties by different Stations are compared, as may be seen from the following tables, given for that purpose. They were taken and arranged from variety tests made by different Experiment Stations of the respective States as given. The varieties are arranged in the tables according to their production of lint per acre, the highest ranking first in each table, the lowest taking last place. All the tables contain the same varieties, except two or three which were absent from the varieties tested.

TEST OF VARIETIES BY ARKANSAS STATION.—Table 1.

VARIETIES.	Seed Cotton.	Per Cent Lint to Seed Cotton.	Lint.
Peerless	1049	32.44	340
Shine's Early Prolific	965	34.46	333
Mammoth Prolific	933	34.33	320
Hawkins	683	36.22	247
Deering's Prolific	799	29.33	235
Herlong	666	31.39	209
Allen	632	30.35	192
Jones' Long Staple	683	27.84	190
Peterkin	516	36.75	190
Southern Hope	584	31.45	184
Truitt	549	31.39	167

TEST OF VARIETIES BY LOUISIANA STATION.—Table 2.

VARIETIES.	Seed Cotton.	Per Cent Lint to Seed Cotton.	Lint.
Peterkin	1680	35.90	599
Jones	1840	30.90	568
Peerless	1560	33.15	517
Herlong	1360	31.60	420
Hawkins	1280	33.30	426
Allen	1640	30.65	402
Truitt	1160	31.93	370
Shine's Early Prolific	960	32.90	316

TEST OF VARIETIES BY MISSISSIPPI STATION.—Table 3.

VARIETIES.	Seed Cotton.	Per Cent Lint to Seed Cotton.	Lint.
Truitt	1048	31.9	343
Southern Hope	1060	28.3	300
Peterkin	801	36.4	292
Jones' Long Staple	905	29.4	266
Mammoth Prolific	793	30.9	245
Allen	869	28.1	244
Shine's Early Prolific	713	31.1	222
Peerless	650	32.3	210
Hawkins	600	30.3	182
Herlong	458	25.7	118

TEST OF VARIETIES BY GEORGIA STATION.—Table 4.

VARIETIES.	Seed Cotton.	Per Cent Lint to Seed Cotton.	Lint.
Peterkin	1829	35.0	640
Hawkins	1852	33.4	618
Truitt	1957	30.2	591
Herlong	1694	31.0	525
Peerless	1601	32.4	519
Mammoth Prolific	1583	31.5	499
Allen	1666	27.1	451
Southern Hope	1582	28.4	449
Jones' Long Staple	1431	30.8	441

It is readily seen from the tables that one variety does not occupy the same position with respect to the other varieties in all the tables. It may be first in one table, as the Peerless in table 1, but occupies the eighth place in table 3, fifth place in table 4, third in table 2. The same variation may be observed with others, and the same variation in per cent of lint to seed cotton. It is plain, therefore, that variety tests are of little value, particularly so when part of the variation may be due to soil, climate or *culture*, *the long and short limb varieties require, it is believed, different culture. The same is being tested and will be reported this year, mainly* to the latter, and too, the plan of securing seed promiscuously over the country for testing varieties, and repeating the test.

read below

THE SELECTION AND CARE OF SEED.

The variation in the foregoing tables should indicate to farmers, and is mainly valuable for that purpose, the importance of securing the best suited varieties, then carefully cultivate and select the planting seed each succeeding year, for the seed is the beginning of the new plant, and contains in itself the first possibilities of a perfect plant. Seed for planting should be carefully cultivated under the best circumstances favorable for that variety's best development. The picking should be from perfect bolls best situated on the stalk in conformity with the type for its reproduction and improve-

ment. By such a method the variety is not only maintained but improved in its special features being intensified. Less seed is required for planting, while a better stand of vigorous young plants are obtained that will grow off more even and faster, since more plant food is stored in the well developed seed to nourish the young plant, and its rapid growth will enable an earlier cultivation with the plow before grass gets a good start, and thereby lessen the expense of hoeing, which is of no benefit to cotton only for thinning. No inferior variety of cotton should be grown, and especially none allowed near an improved variety or that grown for seed. Care should be observed in storing seed that they do not ferment or become damaged in any way until the next planting season. The cotton plant is extremely susceptible to influences that operate upon it, and it responds readily to care and attention, or yields to neglect and improper culture.

THE STAPLE.

The value of the lint depends mainly upon the length and texture of the staple; the varieties tested were graded by experts, Messrs. F. A. Jones and F. G. Millette, of Newport; the price affixed is based on Middling at 7 cents. The price only enables a more extended comparison.

VARIETY.	Seed Cotton per acre.	LINT.	Length staple in inches.	Price Middling 7 cts.
Peerless	1049	340	1 1/16	7 1/8
Shine's Early Prolific	965	333	15/16	6 7/8
Mammoth Prolific	933	320	1 1/8	7 3/8
Hawkins	683	247	1 1/16	7 1/8
Deerings' Prolific	799	235	1 3/16	7 1/2
Herlong	666	209	1 1/16	7 1/8
Allen	632	192	1 7/16	10
Jones' Long Staple	683	190	1 1/4	7 3/4
Peterkin	516	190	1	7
Southern Hope*	584	184	1 7/16	9 1/2
Truitt	549	167	1 1/4	7 3/4

*Weak Staple.

BOTTOM AND TOP BOLLS.

To secure seed from well matured bottom and top bolls for experimental planting and also to determine the difference in quality of cotton from an equal number of bolls from each section of the stalk, 500 matured bolls of Peerless were carefully picked from each section of the stalk, then weighed, ginned by hand and classed. The results are appended in table.

SECTIONS OF STALK.	Seed Cotton.	Per cent Lint.	SEED.	LINT.	STAPLE.
500 Bottom Bolls	8.26	32.11	5.61	2.65	1¼
500 Top Bolls	6.46	33.96	4.27	2.19	1¼

The bolls were not picked from the extreme sections of the stalk. From the data the top bolls are far inferior in production to the bottom bolls. 500 bottom bolls correspond to 637 top bolls.

DIFFERENT DISTANCES OF PLANTING.

In 1890, on the Station, cotton was planted in different width rows and different distances in drill. The same experiments were repeated in 1891, with the same variety and on the same land. In comparing the results of the two years we find a very close relation, which indicates that cotton under precisely the same conditions requires the same distance for the plants and there is an exact distance required for its highest production, but when the conditions are varied the distance must invariably be changed, because of difference in soils, difference in manner of growth of varieties, the season and cultivation, so it is impossible to arrive at even a general rule for the proper distance to plant cotton. This variation of proper distance is shown when the results of tests made by different State's Experiment Stations are compared. In the several tests by the Stations the conditions were not entirely the same, hence, for farmers to know the proper distance to plant their cotton will have to be determined by themselves; and the proper distance when ascertained will

have to be changed in all probability when the important conditions are changed. The correct distance to plant on a soil is of great importance, much more so than it is ever supposed to be by many farmers. Cotton is more frequently planted too close than too wide and especially so on rich soil.

DEEP AND SHALLOW CULTIVATION.

No experiments have ever been undertaken at Newport to solve this much discussed question, because of the almost innumerable conditions that would have to be taken into account and those conditions are rarely the same even on adjacent farms. It is plain to any thinking individual that no general rule, from any number of experiments, could ever be laid down to say that it is either better to cultivate shallow or to cultivate deep. It is frequently essential to cultivate the same crop both deep and shallow. The one or the other method in such cases is determined by the season or by the size or rate of growth of the plant, with respect to its fruiting, etc. If deep or shallow culture is to be followed exclusively, without a change to the other, even the circumstances warrant it, the shallow culture would be decidedly better, because there are more and continuous conditions requiring shallow culture. The prime important conditions that enter into the question of shallow and deep cultivation with cotton, are soil, season and variety, with varied changes in each. First, the soil, if it is properly prepared before planting, there will be no need of deep culture after planting to prepare the soil. The fertility of the soil may require deep plowing to check the too rapid weed growth to induce fruiting, in some cases the fertilizers applied may be insufficient for a poor soil, and deep culture at first may be necessary to prevent an excessive weed growth before fruiting so as not to consume all the plant food or fertilizers before that time. Too much rain at any time during the growing season may cause the necessity for deep plowing. The variety, if long or short limb, will require different culture. These are a few of the conditions which should be considered to decide when to cultivate deep or shallow. A farmer must consider the existing and changing circumstances, and decide for himself which method is most necessary for the continual betterment of his crop.

BARLEY AND RYE.

Barley and Rye were planted in fall at Newport for green soiling, and to compare the growth and yield for that purpose, each was planted on two plats; one plat of each two was fertilized by turning under a good growth of pea-vines before planting. The yields of hay on April 15th from Barley plats are as follows:

PLAT I.—No Fertilizers.....1,600 pounds hay.
PLAT II.—Fertilized with Pea-vines.....2,700 pounds hay.

HAY FROM RYE, APRIL 19TH.

PLAT I.—No Fertilizers.....1,440 pounds hay.
PLAT II.—Fertilized with Pea-vines.....2,700 pounds hay.

HEIGHT, MARCH 15TH—BARLEY.

PLAT I.....15 inches.
PLAT II.....24 inches.

RYE.

PLAT I.....8 inches.
PLAT II.....24 inches.

Barley is much superior to Rye for winter soiling and for hay; it grows more rapidly and upright. Can be cut oftener, begins a new growth quicker and is freer from dirt. They were killed down by cold only a few times during the winter. For soiling, Barley should be planted in early fall in rows highly fertilized, and it will then furnish several cuttings during the winter, then a crop of hay can be cut, if desired, by April the 25th, sufficiently early for a crop of cotton or two crops of peas, or two of sorghum for forage. The hay from the Barley was eaten readily by stock, which was not so with Rye.

GRASSES.

The Grasses that succeeded best in 1890 were retained this year, and mineral fertilizers of various kinds were applied, but without success. The same grasses were grown, with applications of stable manure and pea-vines, separately, with success. It is clear, therefore, that the Station soil, a sandy loam, with yellow clay sub-soil, will not produce grass profitably, unless the mechanical condition of the soil is improved by the use of vegetable matter. The Station soil, as stated heretofore, has been cleanly cultivated with cotton and corn for about forty years.

MANURES

— AND SOME PRINCIPLES IN —

FARM MANURING.

AGRICULTURAL EXPERIMENT STATION

— AT —

ARKANSAS INDUSTRIAL UNIVERSITY,

FAYETTEVILLE, ARK.

BULLETIN No. 19.

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PREFACE.

This bulletin has been prepared strictly for the farmers of Arkansas, to furnish information on many points upon which inquiries have been received at this office, and to supply conveniently similar information to those desiring it. Recognizing the commencement of the use of commercial fertilizers in this State, the bulletin has been more especially prepared to furnish convenient information to enable those contemplating their use to guard against fraud and wastefulness.

MANURES AND SOME PRINCIPLES IN FARM MANURING.

Of the whole number of chemical elements known, not more than fifteen enter extensively into the composition of most soils or into the growth of plants. As some knowledge of these elements is essential to an understanding of manures and their use, they are briefly described below.

OXYGEN is the most active part of the atmosphere, in which it exists in a free or uncombined form, constituting about one-fifth of it. It is the part which causes fire to burn and iron to rust, the part which animals use in their breathing. In soil and water it is combined with other elements, and it is so abundant everywhere that it has been estimated to constitute about one-half the entire weight of the earth. It combines with nearly every other known element and is especially important in the building up and breaking down of all organic matter.

HYDROGEN. This is the substance which chemically combined with oxygen forms water. It is seldom, if ever, found in nature in a free or uncombined state. When separated out it is found, like oxygen, to be a gas, and is distinguished as being the lightest of all known substances.

CARBON. This substance is often seen on lamp chimneys when the flame has been allowed to smoke. It constitutes the chief part of coke and charcoal, and is abundant in all mineral coal. In another form it is familiar to us as graphite, or the "lead" of lead pencils. The diamond is also pure carbon. Here the particles are are so arranged as to form a crystal.

Though a solid, carbon, like hydrogen, will combine with oxygen. During the combination heat is generated, but instead of water, a gas known as *carbonic acid* gas is formed. This gas, as well as water, is formed whenever wood, coal, a lamp or a candle burns. In the wood, coal, oil and tallow, carbon and hydrogen are combined with each other and with other elements, and we cannot distinguish them, but the oxygen of the air searches out the particles, seizes upon them, tears them apart and the new combinations fly away till the water falls as rain and the carbonic acid gas or *carbon-dioxide*, as it is also called, is captured by the leaves of a growing plant.

Carbon-dioxide is also given off whenever an animal breathes, or when plant or animal matters decay, so that the air is never free from it. It is usually found in the proportion of about one part in 250 of air. It is formed in the rising of bread and in the "working" of cider. It is the cause of the foam and biting taste of soda water, and the pleasant taste of drinking water is largely due to it.

Being heavier than air it sometimes collects in wells and cellars to such an extent that persons entering them soon smother. The oxygen so necessary to life is cut off just as though they had gone into water. A lighted candle lowered into the gas would be immediately extinguished for the same reason. Destructive as is a large quantity of this gas to life and fire, a plant cannot grow in an air entirely free from it. We will have occasion to consider this matter later.

NITROGEN. Air is composed almost entirely of oxygen and nitrogen. Roughly speaking, about four-fifths of the air is nitrogen. Unlike hydrogen and oxygen this gas will neither burn nor assist in burning. In that respect it is like carbon-dioxide. Its main purpose in the air seems to be to dilute the oxygen and keep it from acting too strongly on other substances.

Unlike most other elements, the greater part of the nitrogen is in an uncombined condition. It seems by nature best fitted to roam at its own free will. When, however, it becomes united with other elements it forms some very important compounds. It is found in all living matter. Without it no life could exist. When united with oxygen alone it forms several *oxides* which differ from each other in their properties and in the proportions in which the two elements are combined. One of these oxides dissolved in water forms the nitric acid of commerce.

Another common compound, important in this connection, is that of *ammonia*. This is a combination of nitrogen and hydrogen, consisting of one part (by volume) of the former element and three of the latter. Its odor is readily recognized by any one who has smelled the hartshorn bottle. Hartshorn is a solution of the gas in water. This gas is nearly always formed in small amounts when organic matter is burned, or decays in soil. Its odor is often very strong about stables that are not kept clean, especially horse stables. It nearly always occurs in the air in small quantities and is washed out and brought to the ground by rains. It is collected in large quantities during the manufacture of city gas, and is of great importance in the manufacture of ice. It combines with several acids to form salts, some of which, especially the sulphate and chloride, are of importance to the subject in hand.

SULPHUR. This is a substance familiar to all in the form of flowers of sulphur, as obtained at the druggists, or as brimstone, which is sulphur molded into sticks or rolls.

When sulphur burns in air it gives off the stifling odor peculiar to many matches. Here a combination of sulphur and oxygen is formed just as with carbon in forming carbonic acid gas. This gas is known as sulphurous acid gas. When combined with more oxygen it forms an oxide which dissolves

in or unites with water to form the sulphuric acid (sometimes called *oil of vitriol*) of commerce. It is this acid which, when united with copper forms blue vitriol (blue stone), with zinc, white vitriol, and with iron, green vitriol.

PHOSPHORUS. If a piece of bone be burned till white there will be left a larger proportion of ash than from almost any other substance. The ash really composes about two-thirds by weight of the thoroughly dry bone. This ash is peculiarly different from all other ash with which we are familiar, in that it is composed almost entirely of lime combined with oxygen and a substance which has been named *Phosphorus*. Pure phosphorus is a waxy like solid which burns very readily in air when dry and for this reason must be kept under water. It has the property of giving off light in the dark, and it is due to it that a streak of light appears upon a wall over which a match has been drawn. Phosphorus is a poison. Like carbon and sulphur when burned in air it produces an oxide. This oxide is known as *phosphorus pent oxide* to distinguish it from other phosphorus oxides which also occur. United with water it gives us phosphoric acid.

CALCIUM. Quick-lime is composed of two elements, oxygen and a metal-like substance known as *calcium*. In other words, it is oxide of calcium. Pure calcium is a golden-yellow metal which has little interest to us here excepting as being one of the elements of which lime is composed. When limestone is exposed to a high heat, as in a lime kiln, it is separated into quick-lime and carbon-dioxide.

Quick-lime is never found as such in nature, but carbonate of lime is found in great abundance and in many forms. Besides as limestone, it occurs as marble, chalk, marl, etc. It also occurs in solution in most well and spring waters, and it is because of this that such waters are called hard waters.

MAGNESIUM. There is a substance similar to lime called *magnesia*. Like lime, it is an oxide of metal. This metal is light and brittle and burns in air with a very brilliant flame. So intense is the light of the flame that it is used for taking photographs at night and in dark caves. When it burns its oxide remains as a white solid, which solid is magnesia. Magnesia may also be formed by burning or heating magnesium carbonate in the same way as lime is formed from limestone. The "magnesia" obtained in white bricks at the druggists is an artificially prepared carbonate.

POTASH. Any one who has gone through the unpleasant task of setting up a lye leach, and the still more unpleasant task of making soap ought to know what potash is, for it is mainly this that constitutes the active part of lye. Pure potash is a solid composed of oxygen and the metal *potassium*. It is an oxide of potassium. So great is its attraction for water that it is nearly always found in union with it. It will take up water from the air with great readiness. For that reason it is usually seen only as *hydrated* potassium oxide. Hydrated means united with water.

Potassium is a soft metallic substance, remarkable for its great attraction or affinity for oxygen. So great is this affinity that the metal thrown upon water will decompose it, burning with a brilliant flame and setting hydrogen free. For this reason the metal can be preserved only by keeping under benzine or some similar substance. The pure metal is obtained only with difficulty and was unknown until the early part of the present century.

SODA. This subtance is very similar to potash. It is the oxide of the metal sodium. All the properties ascribed to potassium in the former paragraphs will apply equally well to sodium. It is not necessary to here state the distinctions

between them further than that potash is perhaps a stronger alkali than soda. Potash is also necessary to plant life, while soda is not and cannot there replace the potash.

Soda is the substance which in hard soap takes the place of potash in soft soap. The common way of making "home made" by putting common salt in soft soap is probably familiar to many. Ordinary washing soda is a carbonate of soda. It acts on much the same principle as soap. The so-called soda used for cooking purposes is also a carboate. It contains twice as much carbon dioxide to the sodium as the true carbonate of soda.

IRON is too well known to need describing here. The so-called iron rust is oxide of iron. The yellow mineral seen in coal, and so often taken for gold ("Fools gold") is *iron pyrites*, or sulphide of iron. Here sulphur stands in the same relation to iron as oxygen in the oxide. Add oxygen to this sulphide and the three elements together form sulphate of iron. This change often occurs in certain soils, especially during warm weather.

MANGANESE. This metal is very similar to iron. It is especially abundant in this state. Manganese, as bearing directly on agriculture is of doubtful importance.

ALUMINA is of importance to us here only because it constitutes a considerable portion of most of our soils. It occurs wherever we find clay. Though important in soils, it apparently has no value as a plant food. It is the oxide of the metal aluminium.

SILICON. This is the element which united with oxygen, forms *silica* or pure sand. Silica constitutes a large part of our soils and most rocks. It is found in its purest form in quartz crystals. Glass blowers' sand is nearly pure quartz. Darker sands owe their color mainly to the iron they contain.

CHLORINE. All the substances above discussed, except the first, form oxides which play an important part in the chemistry of agriculture. Not so with chlorine. Strictly speaking, so far as known, it has no oxide. Hydrogen unites directly with chlorine to form a gas which dissolved in water constitutes the hydrochloric or *muriatic* acid of commerce. Common salt is a combination of sodium and chlorine. Hydrochloric acid is produced largely as a by product during the manufacture of sodium carbonate from common salt. Pure chlorine is a poisonous yellow gas, very irritating to the throat and lungs.

GEOLOGY AND AGRICULTURE.

Geologists divide the surface of a country according to the nature of the rock from which it was formed. By studying the rocks as they find them cropping from beneath the soil of various parts, they are enabled to divide them into groups which may be recognized with more or less distinctness, in widely different places, even though outcroppings of numerous formations intervene. They find the composition of each group of rocks to be quite uniform wherever found. Soils are formed by decomposition of rock, and it would seem that by knowing the geology of a given portion of country and the character of the soil of similar geological formations we might be aided in securing a knowledge of the soil in question. This may be true to a considerable extent in some parts. In England where the matter has been more thoroughly studied than in this country, a knowledge of the geology of the different parts seem to have enabled the farmers to better settle upon methods of cultivation and treatment adapted to their particular soils.

While there are, frequently, large areas of soil that are quite uniform in character, owing to the uniform character of the rocks from which they were formed, yet as these rocks, and especially the soil formed from these rocks are more or less mingled with one another, and as such mingling may greatly change the character of the soil, a knowledge of the geology of a country can give only a very general knowledge of its probable productiveness and little or no knowledge of the treatment necessary to improve that productiveness. Such knowledge is still more confused from the changes produced by the growing of trees and plants of all kinds, and by weathering and washing of the surface, the influenc of which varies with different exposures.

ALLUVIAL SOILS. A very large part of our soils also, are not formed by decomposition of the original rock of the locality, but are made up of material prepared elsewhere and brought to the place by wind and water. The channels of many large rivers are continually changing, removing soil from one place and depositing it in another. Wherever water washes the ground during a storm, it carries with it suspended particles which, after a greater or less time are deposited. Such soils are often of superior quality because rich in partly decomposed animal and vegetable matter. The overflow of the banks of the Nile, Egypt, has for centuries kept the land fertile by adding a layer to its surface each year.

CLASSIFICATION OF SOILS.

All soils present certain characteristics, readily recognized by the eye, by which they may be described in a general way and some knowledge of their nature conveyed to those who have not seen them. Certain names of very flexible meaning are almost universally applied to certain different classes of earth. The leading characteristics upon which such group-

ings are based are fineness and general nature of particles; physical appearances when plowed or cultivated, especially with regard to their behavior during wet and dry seasons; color, and in many cases the character of the vegetation which grows upon them. As there are a great number of each of these qualities it can hardly be expected that any term or terms will contain a full and accurate description of a given soil. Of the classification given by Prof. S. W. Johnson in his *How Crops Feed*, his brief definitions ofthe various leading classes are here quoted:

"GRAVELLY SOILS are so named from the abundance of small stones or pebbles in them.

"SANDY SOILS are those which visibly consist to a large degree, 90 per cent or more, of sand, i. e., of small granular fragments of rock, no matter of what kind.

"CLAYEY SOILS are those in which clay or impalpable matter predominate. They are commonly characterized by extreme fineness of texture, and by great retentive power for water; this liquid finding passage through their pores with extreme slowness. When dried they become cracked or rifted in every direction from the shrinking that takes place in this process.

"LOAMY SOILS are those intermediate in character between sandy and clayey, and consist of mixtures of sand with clay, or of course with impalpable matters. They are free from the excessive tenacity of clay, as well as from the too great porosity of sand.

"The gradations between sandy and clayey soils are roughly expressed by such terms and distinctions as the following contains:

	Clay or Impalpable Matters.	Sand.
Heavy Clay	75-90 per cent.	10-25 per cent.
Clay Loam	60-75 "	25-40 "
Loam	40-60 "	40-60 "
Sandy Loam	25-40 "	60-75 "
Light Sandy Loam	10-25 "	75-90 "
Sand	0-10 "	90-100 "

"CALCARIOUS OR LIME SOILS are those in which *carbonate of lime* is a predominating or characteristic ingredient.

"MARLS are mixtures of clay or clayey matters, with finely divided carbonate of lime, in something like equal proportions.

"PEAT OR SWAMP MUCK is humus resulting from decayed vegetable matter in bogs and marshes. A soil is peaty or mucky when containing vegetable remains that have suffered partial decay under water.

"VEGETABLE MOLD is a soil containing much organic matter that has decayed without submergence in water, either resulting from the leaves, etc., of forest trees, from the roots of grasses, or from the frequent application of large doses of strawy manures."

"OCHERY OR FERRUGINOUS SOILS are those containing much oxide or silicates of iron; they have a yellow, red, or brown color.

HUMUS.

The dark color of the first few inches of many soils stands in strong contrast to the color of those soils at a greater depth, owing to the presence of certain matter readily removed by carefully burning a quantity of the earth. This material is composed mainly of the remains of partially decomposed plants and has been given the name of humus. It is found in nearly all soils but varies greatly in amount and the depth to which it occurs. In very poor sandy soils it may amount to little more than one per cent, while in rich prairie soils it may constitute as high as 12 or 15 per cent.

In certain marsh lands it even constitutes more than half the entire dry matter. The material of peat bogs is very similar to or identical with the humus of our soils. Peat or muck is usually formed where the rotting of plants takes place very slowly as under water. It is found most abundantly in cool climates. Apparently but little occurs in this state. As plants decay upon the surface of a soil they become mixed with it to form its humus.

An examination of pure humus will show it to be composed of carbon, oxygen, hydrogen, a smaller amount of nitrogen and the mineral matters before mentioned, viz., lime, magnesia, silica, etc. It is in fact composed of the same elements as the plants from which it is formed, but here the parts have been so arranged as to form new substances—compounds which differ greatly in their properties from those generally found in plants. Humus is important in soils partly because of the relation it holds to the combined nitrogen. It also exerts an important influence upon the physical condition of soils, such as the temperature, retention of moisture and compactness and looseness.

THE LIFE OF THE SOIL.

It is now generally believed that the decay of all animal and plant substances is brought about through the agency of living organism almost as invariably as they are built up by other forms of life—the animal or the plant. Minute as are the individuals which produce this decay their immense numbers make up for their size. Everywhere about us the world is teeming with life of which we see only the effect. Often grape juice becomes wine, apple juice becomes cider and cider is changed to vinegar, milk sours, fruits rot, flesh becomes putrid and even the living animal itself is attacked

and succumbs to a fever or a wasting canker. Wherein lies the cause? In a very large number of cases there is direct evidence to prove that these changes are the results of the growth of certain low forms of life; each adapted to a special purpose; each an outgrowth of germs or "seeds" which are the necessary forerunners of the active beings, the products of previous generations of similar life.

Fruit and vegetables are preserved by cooking and sealing air-tight in cans. Unseal the can and expose the contents to the air and they soon spoil. The real cause of the spoiling is that the substance is suitable for the growth of low forms of life of which nearly all air contains the germs. This life in growing acts upon some part of the material in which it occurs breaking it up and changing it to other substances some of which are unpleasant to the taste and smell and some exceedingly poisonous. On the contrary others may be pleasant to the taste and some of great value for various purposes. Alcohol is found in wine and cider and acetic acid in vinegar. Putrid flesh pours forth gases of intolerable odor. All these are products of changes of some portion of the original substance. These changes are in some way brought about through the agency of life. Putrefaction and fermentation are for the most part a breaking down of substances previously built up by higher plants and animals. They are believed to be those changes in which the microscopic forms of life take the most active part. The latter is known to be not entirely confined to low forms of life but to be brought about by some of the higher as well.

The soil everywhere about us is teeming with innumerable varieties of microscopic forms of life which are assisting in preparing substances suitable for the future growth of farm crops, are decomposing plant and animal matters and changing them back to the forms from which they were built up. Thus, during the decay of certain substances ammonia is

formed from the nitrogen and hydrogen which the substance contains. Other forms of these beings cause this ammonia to be changed to nitric acid. Certain of these organisms play an important part in the development of a certain group of plants—The Leguminoseæ—whereby these plants are endowed with certain powers believed not to belong to most others.

SOIL WATER.

FREE WATER. Most soils have free water at their surface immediately after heavy rains and many, especially undrained clays, retain it for a considerable time. Probably there are few if any naturally fertile lands that do not have free water standing in them at greater or less depth below their surface during the entire year. The surface of this free water in soils is known as the *water table*. We sink a well and sometimes go to a depth of ten feet or more before we reach sufficient free water to have it collect for our use. Whatever the depth, however, at which we reach it we find its depth in the well usually varies with the time of year and length of drouth.

Soils which have not sufficient drainage are usually of a mucky, peaty or clay character. Their need of drainage is usally apparent from the presence of free water at or near the surface for an unreasonable long time after rains; the stunting of crops, the growth of moss upon the surface, the cracking of the soil during drouth, etc. These are all conditions which may be remedied by artificial drainage provided the lay of the land is such as to give an outlet.

Drainage benefits the land not only by removing the surface water but also by improving the tillage qualities and capillary power of the soil. Stir while wet a quantity of al-

forms of matter containing this class of phosphates (notably various forms of organic matter, such as dried fish, cotton seed meal, etc.), differs greatly from either rock or bone.

It is generally conceded that the reverted phosphates are nearly or quite as valuable as the soluble phosphates. Those charged with official fertilizer inspection and valuation rate the two classes as being nearly equal and sometimes equal in value. Because of the readiness with which these two classes of phosphates may be utilized by plants, they are frequently classed together under the head of *available phosphates*.

Careful experiments carried on under the directions of the Agricultural Experiment Station at New Haven, Connecticut, throws some light upon the question as to whether or not the increase in yield is sufficient to overcome the difference in cost between the soluble phosphates and the untreated phosphates. The details of these interesting experiments are given in the reports of that Station for 1887-8-9. The following brief conclusion is from the report of 1888, page 140:

"In general, it has been shown that in some cases the raw phosphates may be more profitable to use than dissolved phosphates, that their effects are more lasting, and that the immediate effect in some cases may be as great as the same money value of dissolved phosphate. This is a matter of great importance to the users of commercial fertilizers and will receive further study on the part of the Station."

POTASH.

The form in which potash usually occurs in soil is that of complex mineral compounds which, as such, are very insoluble in water. The agents of rock decomposition are gradually setting free in the soil small quantities of this pot-

present in each of these forms, and the statement of the analysis of a fertilizer gives the per cent of each form found to exist in the material.

BEHAVIOR OF SOLUBLE PHOSPHATE IN SOIL. When a superphosphate is added to a soil, the soluble phosphate which it contains soon becomes insoluble in water. The form which it now assumes is probably similar to that which has been called reverted phosphate. There is no proof that it is always fixed in the same form of chemical compound, and the nature of the fixation probably depends largely upon the particular soil to which it is added.

The supposed explanation of the benefit derived from the use of the soluble form of phosphates is, that it, before fixation, becomes by water more widely distributed throughout the soil and is thus more likely to be brought in contact with the roots of plants. It is likely, too, in a much more finely divided form than could be attained otherwise.

Fertilizers are frequently mixed with loam, ashes, etc., so that they may be more evenly distributed. Such mixing, in case of superphosphates, should be made, if at all, only immediately before applying, and then all should be in a dry condition, otherwise there is danger of a considerable portion of the water soluble phosphates being changed to the reverted before it reaches the soil.

COMPARATIVE VALUE OF DIFFERENT FORMS OF PHOSPHATES. The question has frequently been raised as to the relative value of the three different forms of phosphates for crops. Soluble phosphate is of equal value from whatever source.

Of the different substances from which insoluble phosphates are derived, bone is more readily decomposed than rock — some kinds of rock are more readily decomposed than others—and the relative rate of decomposition of other

SUPERPHOSPHATES. Because of the slowness with which phosphates of the above nature decompose in soils certain methods have been resorted to whereby they are made soluble before applying. By acting with sulphuric acid upon bones or rocks containing insoluble phosphates which is decompose and a phosphate formed which is soluble in water. Manures containing these soluble phosphates (artificially prepared) are called superphosphate. This phosphate is one of the three forms of phosphate of calcium. Phosphates of potash, soda, and ammonia, are soluble in water, but they seldom occur in manures.

REVERTED PHOSPHATES. To revert is to go back. Reverted phosphate is a term applied to a portion of a superphosphate, which from some chemical change has been onverted from a compound readily soluble in water to a compound which is not soluble, but which may be made so by the action of weak acids. While reverted phosphate of calcium is, as compared with insoluble phosphate of calcium, nearly equally insoluble in pure water, it is much more readily so changed as to become soluble. While the so-called insoluble phosphate (tri-calcic phosphate) may be readily converted into the soluble phosphate (superphosphate) by the strong acids: nitric acid, hydrochloric acid and sulphuric acid, the weaker acids of the soil and plant roots make it soluble only very slowly. On the contrary, these weak acids are believed to be capable of acting on the reverted phosphate with far greater rapidity and ease.

Nearly all commercial superphosphates contain at least a small proportion of both reverted and insoluble phosphates. Generally speaking, the greater the amounts of these present in proportion to the amount of soluble phosphate the poorer the quality of the article. Chemical analysis is capable of showing approximately the amount of phosphates

Phosphorus is found in soils only in combination with other elements. It is there present mainly in the form of compounds known as phosphates. Phosphates are composed of some base chemically combined with phosphoric acid. Most commonly in soils this base is lime and the phosphate, phosphate of calcium. The ash of bones is almost entirely phosphate of calcium.

The phosphates which exist in soils are mostly in a very insoluble condition. They are gradually made soluble by the agents that are active in the decomposition of rock. The rapidity with which they are so converted into plant food varies greatly with the soil and the different conditions of that soil as to crops, cultivation, etc. Frequently it occurs that the decomposition is not fast enough to supply the needs of the crops. At such times manures containing phosphates may be more or less beneficial to that soil. Generally speaking, phosphates in manures are considered to be second in value and importance to nitrogen only. For particular soils and crops under certain conditions they may prove to be of even greater value than the combined nitrogen of the manure.

The phosphates in manures, especially in commercial manures, may exist in one or more of three forms, with the nature of which forms it is highly important that every progressive farmer should be familar.

TRI-CALCIC PHOSPHATE (Insoluble Phosphoric Acid). This is the form in which phosphorus exists in most soils, in bones and in most rock which are used for manurial purposes. It is the form from which the phosphorus is yielded with most difficulty to plants. Bones being of an organic nature are more rapidly disintegrated in the soil than the rock from which the so-called *rock phosphates* are derived.

LOSS OF COMBINED NITROGEN FROM SOILS. The two chief sources through which nitrogen is removed from soils are crops and drainage.

The amount of nitrogen removed in crops varies of course with the kind, quality and yield. In the following table is given the average number of pounds of nitrogen in each 1000 pounds of the various leading products of this State:

Seed Cotton	25.0	Wheat Straw	5.4
Tobacco, leaf	34.6	Timothy Hay	9.4
" stalk	24.6	Red Top Hay	12.6
Corn, shelled	16.8	Clover Hay	19.7
" on cob	14.0	Cow Pea Hay	26.6
Oats	19.8	Cow Pea, kernel	33.3
Wheat	18.8	Potatoes	3.2
Oat Straw	6.4	Sweet Potatoes	2.3

Nitrates, unlike ammonia salts, are readily washed from soils in which they occur. Soils have little or no power to fix them in insoluble combinations. All combined nitrogen of soils may be gradually converted into nitrates. The result is that drainage is a large and almost constant source of the removal of nitrogen from soils. The loss is greatest upon soils bare of vegetation, active vegetation takes up nitrates and preserves them for future use.

From this point of view it seems profitable to keep the soil covered as much as possible with green crops. It is another good argument in favor of sowing peas in corn fields, to grow after the corn has ripened.

PHOSPHORIC ACID.

Next in importance to the supplying of nitrogen to crops, from an agricultural standpoint, is the supplying of phosphorus, phosphoric acid or phosphates.

thus serves as a continual source of available nitrogen for crops. It has been found[1] that continuously unmanured and uncropped land gave in drainage-water from the first forty inches in depth, an amount of nitrates equal to more than thirty-five pounds of nitrogen per acre, annually, as an average of the last twelve of twenty years following the last addition of nitrogen to the soil by plant growth or manures. Reliable estimates of the amounts of nitrogen that may have come from other sources than the soil, fixes the maximum amount at not more than one-sixth of the entire amount in the drainage water, leaving the remaining thirty or more pounds to be derived from the decay of humus. Wheat and barley have been continuously grown for forty years[2] or more upon land which in the meantime has received no nitrogen whatever, except from the atmosphere, and yet the amount from this source is estimated from reliable data to be but a small proportion of that removed from the soil in the crops harvested. Indeed, the amount from the atmosphere has been estimated to be even less than that found to be removed from the same land by drainage. The nitrogen which accumulates in soils from the continuous use of farm-yard manure has been shown to produce a marked increase in the yield of barley for twenty years after its last application.[3] Analyses of soils, of which samples were collected at the same time and under the same conditions show the amount of nitrates present to vary quite directly with the amounts of organic combined nitrogen present.[4] Soils containing an abundance of humis but no nitrates or other soluble nitrogen compounds, have been found to contain an abundance of nitrates after remaining for several days under conditions known to be suitable for their production.[5]

1. Rainfall and Drainage at Rothamstead.
2. Broadbalk and Hoose Fields, Rothamstead.
3. Hoose Field, Plot 7.
4. Rothamstead Wheat and Barley plots.
5. Lawes & Gilbert on "Some Points in the Composition of Soils."

matters in air. Both these substances are brought to the ground by rain and dew. Rainwater is seldom, if ever, free from them. The amount contained is, however, usually small, varying with the place, time of the year, and other conditions. It is estimated by Sir J. B. Lawes, of Rothamstead, England, that an average of about five pounds of combined nitrogen per acre is annually brought to his soil by rainfall and dew. Though the amount from this source at some other places, especially near large cities, has been estimated to be much larger, yet the data at hand seems to justify us in believing that in ordinary farm districts, the yearly amount of such supply would be not enough to equal one-third the combined nitrogen removed from an acre in harvesting an average crop of wheat. We must look elsewhere for the supply.

It is known from numerous experiments that soils, when exposed to the air under certain conditions will have increased to them a certain amount of combined nitrogen either by absorbing it from the air or in some way not understood, having converted into a combined form, usually a nitrate, a portion of the free nitrogen that is nearly always contained in the pores of properly drained soils. This increase is, however, small, and, like that received from the air, far less in amount than is ordinarily removed from the soil by crops and drainage.

The developments concerning the formation of combined nitrogen through the agency of leguminous plants may assist materially in explaining the source of the nitrogen of the humus of soils. To what extent this agent may have assisted in that accumulation can as yet be only surmised.

HUMUS, A SOURCE OF NITROGEN FOR CROPS. There are many good reasons for believing that the inert combined nitrogen of soils is being slowly converted into nitrates, and

roots. It has been shown that plants may take up and make use of nitrogen existing in certain simple organic compounds, but as these compounds exist in soils only under certain special conditions, such as, after the addition of certain classes of somewhat rare manures, they do not furnish any considerable source of the nitrogen supply of crops. So, too, it has been pointed out that legumes may make use of nitrogen which is unavailable to most plants. Aside from these exceptions the usual form in which nitrogen is taken up is either that of nitrates or of some salt of ammonia. In general, complex organic compounds in which nitrogen exists in soils or is applied to soils are broken up and the nitrogen converted into one of these forms before it is suitable for plant food. Thus, if we supply dried blood, animal flesh or cotton seed meal to a soil they purify, and at least a portion of the nitrogen in the complex albuminoids is converted into ammonia and probably nitric acid (nitrates), before it is taken into the plant.

SOURCE OF NITROGEN TO SOILS. If plants obtain their nitrogen from soils, the manner in which the soil obtains its supply is important. It is as yet imperfectly understood.

The atmosphere contains at nearly all times minute traces of combined nitrogen either in the form of ammonia, nitric (or nitrous) acid, or of floating particles of organic matter. When wood, coal and many other organic substances burn in the air a part of their combined nitrogen is converted into ammonia and is carried away in the smoke. So, too, when organic matter decays on the surface of the ground a certain amount of ammonia is set free. Nitric acid is formed under certain special conditions in the air, probably by direct union of oxygen and nitrogen during thunder storms; possibly also by oxidation of ammonia. It also, like ammonia, is formed in small quantities during the burning of organic

that it may not be one of the sources. It *has* been demonstrated that the free nitrogen of air may be made useful to such plants.

When the fresh roots of *legumes* are examined they are generally found to have upon them numerous knots, warts or *tubercles*. An examination with a powerful microscope of the tubercles grown on these plants will show them to contain numerous minute forms of life known as bacteria. If a bit of the juice from one of these tubercles be pricked into the root of a leguminous plant previously grown in a condition not suitable (from lack of seed) to produce tubercles the result will generally be the production of a goodly crop of them. The same will occur if the extract of soil containing the "seed" be placed in contact with such roots. It still further appears from the experiments mentioned, viz., those to which soil extract was added, that increase of nitrogen occurred only in those plants which bore tubercles. The necessary conclusion seems to be that the free nitrogen of air may, through the agency of these warts, or the life within them, be brought into subjection for the use of the plant upon which they grow. So far as is yet known, only leguminous plants produce these warts. They are the class of plants that have been termed nitrogen gatherers, and justly, as appears from the above. As yet, all evidence goes to prove that other plants get their nitrogen from sources other than the free nitrogen of the air, and it by no means follows from the facts above cited that legumes do not as naturally grown get at least a portion of their nitrogen from other sources. On the contrary, there is much proof that they do. Whether or not any of these other sources may be different from those common to all plants has yet to be determined.

There is little doubt that, with possibly slight exceptions, all nitrogen farm plants receive is taken through their

The total amount of combined nitrogen in soils varies greatly and, within certain narrow limits, directly with the humus. In certain very sandy soils of northern Michigan it has been found in quantities not greater than 0.03 per cent. In the rich bottom lands of the southern portion of the same state, it constitutes as high as 0.37 per cent. In the first instance, the total quantity per acre would amount to not far from 1,440 pounds, while in the second instance the total pounds per acre would not be far from 17,000.

SOURCE OF NITROGEN TO PLANTS. Many experiments have been carried on to determine, if possible, whether or not plants are capable of getting a whole or part of their necessary nitrogen from the free nitrogen of the air.

The conclusion first arrived at by very careful experimenters was, that plants cannot make use of such nitrogen. Of later years, certain experimenters have found that if water were passed through fresh soil in which beans, peas or clover had been growing, and a small quantity of this extract were added to certain plants growing in soils containing no combined nitrogen, considerable quantities of such nitrogen in excess of any added was found in the plant. The plants which gave these results belong to a certain family known as leguminos plants, which includes all plants having the peculiarly formed blossom characteristic of peas. To this class belong the beans, vetches, lupines, clovers and others. These plants had long been known to flourish under conditions not suitable to other plants. It had been pretty conclusively shown that they were capable of getting nitrogen from some source barred to other plants. The first experiments above mentioned seemed to demonstrate that this source was not the free nitrogen of air. The inert nitrogen of humus seemed to be the probable source. It has not yet been demonstrated

SOIL NITROGEN. Nitrogen exists in soils in forms which may be divided into two classes dependent upon its immediate value as plant food:

I. *Available*,

Nitrates (and nitrites),
Ammonia salts.

II. *Unavailable*,

As free nitrogen,
As combined nitrogen,
In living organisms,
In undecomposed plant or animal matter,
In humus.

By available nitrogen is meant that in a condition to be at once used by the plant. The unavailable may be in a condition from which it can be readily converted into the available, or it may not. The available nitrogen consists chiefly of nitrates and of ammonia salts. The unavailable combined nitrogen may be present in at least three general forms as indicated above. The first of these forms is converted into the second upon the death of the organism of which it forms a part.

The second class may, during the decay of the substance to which it belongs, be converted either into available nitrogen, the combined nitrogen of humus or be liberated as free nitrogen. To what extent it may assume each of these forms depends upon conditions not yet understood. By far, the greater part of the combined nitrogen of soils exists as a component of humus. Because a greater part of such nitrogen cannot be immediately used by most plants, and because it is made available only with difficulty it is called *inert* nitrogen.

rives from the soil. Its nature being similar to that of the plants from which it is derived, less than one-tenth of the dry matter of this manure consists of elements that can afford nourishment to plants. When we remember that such manure often contains from one-third to three-fourths its weight of water, we see how large a proportion of other matter we must handle and transport to supply a small amount of the material which the plant needs.

Knowing the needs of the plant, the farmer often purchases and supplies these substances in a more concentrated form and obtains equally as good or better results than would come from the use of many times the weight of barnyard manure. It is not, at present, the purpose to encourage or discourage the use of such concentrated manures or "commercial fertilizers," but rather to point out some of the principles of their action and suggest methods whereby each farmer may decide for himself whether or not he can, under his peculiar conditions as regards soil, crops, markets, etc., economically use them. As to farm-yard manure, it is to be hoped that no reader of this bulletin fails to carefully preserve and make use of all that his farm will produce.

Of the substances of plant growth to which reference has been previously made, those in which soils are most likely to be deficient are here named in order of their relative importance in manures as follows: Nitrogen, phosphoric acid, potash and lime.

NITROGEN.

Nitrogen is needed by more soils, and is more expensive than the others because of sources and the difficulty of obtaining it in an available form, and because of the readiness with which it is removed from the soil.

Looked at in one light, the living plant is simply a machine for converting these elements, crude material, into finished organic matters, such as constitute the greater part of our food and clothing, and such as serve to supply material from which other living machines, the sheep, the cow, etc., build up the remainder. Looked at in a similar light, the purpose of agriculture is to furnish the conditions best suited for the working of these machines. A good soil well cultivated are conditions necessary to the plant. Neglect cultivation or a sufficient supply of suitable plant material and the working of the machine will lag or completely stop.

Unless irrigation is practical, the farmer need not trouble himself about the material for the nine-tenths of his crop. They come and go with the wind. A small omission from the deed of a farm may make the balance of it worthless. The absence, or partial absence, from the soils of any one of a half dozen elements which form part of the other one-tenth of farm crops may prevent or hinder the making use of large quantities of otherwise valuable material. One hundred pounds of wheat contains but two pounds of nitrogen, and yet the absence of this two pounds will prevent the growth of the entire hundred pounds of grain and more.

When a soil is naturally deficient in any one or more of the half dozen elements above referred to the deficiency may be supplied by the application of manures. When the soil contains an abundance of these materials existing in an unsuitable condition for plant food, they may be converted into the proper form by the addition of such manures as lime and plaster, or the amount gradually made available by the natural decomposition of the soil may be supplemented by the addition of manures containing the elements needed.

Barnyard manure, decaying straw, etc., contain a limited amount of all the various substances which the plant de-

except that it does not extend so deep. Upon drying, a crust forms in which the soil particles lie close together, thus forming numerous capillary tubes well suited to draw off the water from below. Break this crust by cultivation and the capillary power at the surface is in a measure broken, thus preventing to a great extent the unnecessary loss of moisture. If the crust is not removed, it also prevents the entrance of air which is necessary to the growth of roots.

HYGROSCOPIC WATER. Hygroscopic water is the water that remains in the soil when it is apparently dry. It consists usually of a very thin layer of moisture upon the soil particle, too thin to be seen and felt, but thick enough to yield a considerable quantity of water when heated in such a manner as to collect that given off. Hygroscopic moisture may also be defined as that taken up by a perfectly dry substance from a moist atmosphere. Nearly all substances with which we are familiar have this hygroscopic power to a considerable extent. Paper, cotton, wool, silk, hay, grain, etc., though apparently dry, frequently contain as high as ten to fifteen per cent hygroscopic moisture—depending upon the condition of the air in which they are kept.

It is mainly from the capillary water of soils that most farm crops derive their supply.

THE PURPOSE OF MANURES.

Carbon, hydrogen and oxygen which constitute more than nine-tenths of the dry matter of farm crops, are derived from air and water. The other one-tenth of dry matter is made up of varying amounts of several elements, all but one of which are necessarily derived entirely from the soil. That one (nitrogen) is by most plants derived entirely from that source.

that where it comes in contact with the glass it will be higher than elsewhere. Hold a clean piece of window glass in the water and the same thing will be seen to occur on all sides of it. Insert in the water the end of a very small glass tube and the water will be seen to rise in it to a height of several inches. The finer the tube the higher the water will rise. The power of water to rise in such conditions is called its *capillary power.*

The space between the particles of soils form large numbers of these little capillary tubes. When rain falls upon a well drained soil that which remains after the free water has settled away is known as the capillary water. The amount which so remains depends upon the size and nature of the particles which make up the soil. Generally the finer the particles the greater the amount of water retained. For this reason clay and peat soils usually retain much more than sandy or gravelly soils. The more organic matter or humus a sandy soil contains the greater its capillary power. The addition of farm yard manure and the plowing under of green crops on light soils improves their capillary power, and hence, their power to retain moisture during drouths.

The water at the immediate surface of soils is being continually removed into the atmosphere by evaporation. As it is removed more comes from below to take its place until the soil has become uniformly dry to a considerable depth. The rate at which the moisture is thus removed depends upon the condition of the soil surface. If this be hard and compact the loss will be much more rapid than if loose and mellow. A mulch of partially rotted straw, sawdust, or even loose sand will check loss of water by evaporation. Grass and other plants growing on land increase evaporation because much water escapes through the leaves.

A dashing rain upon a soil puddles the surface. The result is the same as in cultivating a heavy soil while wet,

most any but a very sandy soil and it will upon drying become caked into clods or lumps which can be broken only with difficulty. By a little careful observation it may be seen that by thus stirring it, we have broken down numerous very small lumps of soil, and that the particles which composed them have run together, forming a more or less liquid pudding-like mass. Instead of there now being, as in a mellow soil, numerous small collections of particles with spaces between them the individual particles lie as close together as their form and the water about them will permit. As the water dries away, the particles cohere to one another till the shrinkage becomes sufficiently great to form fissures between large masses of them. This condition is reached in many soils when left to themselves. The water itself seems to cause the particles to run together and the matter is only aggravated when by undue haste or necessity we attempt to work the soil before it is sufficiently dry. Plow if possible such soils in a dry condition and they break into clods most unsuited for plant growth. Plow in a wet condition and they upon drying form ridges about as suitable for cultivation and cropping as rows of sun-dried brick. Ridges which it is almost impossible to mellow, and which are almost or quite impervious to roots and air while water penetrates them only with difficulty till it has sufficiently wet them to break them down and run the particles into a somewhat more level surfaced mass.

Remove the excess of water by tile drains and the soil becomes gradually more and more mellow. By successive dryings and wettings it forms numerous small spaces between small lump masses. Air can penetrate, roots can penetrate, and the soil is in that porus, sponge-like condition which admits of the retention of a large amount of water without clogging the air passages.

CAPILLARY WATER OF SOILS. Pour a quantity of water into a clean glass tumbler or other dish and it will be noticed

ash, converting it into forms soluble in water. Though the process is usually slow yet in those soils containing an abundance of those minerals which contain potash it is usually quite sufficient for the needs of most crops. When it is not sufficient it may be hastened by the addition of certain minerals, such as lime, marl and plaster. In light sandy soils, however, and on some soils composed largely of organic matters such as peat or muck lands there is frequently a deficiency of potash compounds so that the amount made soluble from year to year is not sufficient to supply the needs of our crops. In such cases the addition of potash in some of its forms soluble in water may prove highly beneficial. Especially is this true for certain classes of crops, notable among which are clover and peas.

POTASH MANURES. The forms in which potash is usually applied to soils is either that of a chloride, a sulphate, as part of an organic compound or in ashes in the form of a carbonate. As to which of these forms is most suitable there has been much contention, especially with regard to the first two.

It is claimed, on the one hand, that chloride of potash is injurious to certain crops, especially potatoes and tobacco; that it gives potatoes of poor quality and injures the burning quality of tobacco. On the other hand this is disputed. From the results of the experiments upon this point it would appear that under certain conditions the chlorides would prove injurious while under others they would not. Any injurious results which may occur are apparently due to the chlorine. Notwithstanding these apparent injuries there can be little doubt that fertilizers containing considerable of chlorine are much used, not only with good results as to increase in yield, but without noticeable injury to the quality of the crop. In fact the use of common salt (chloride of soda)

upon wheat often shows a noticeable improvement in the apparent quality of the berry, making a heavier and plumper grain.

If it be conceded that chloride of potash, because of the chlorine it contains, has, when in manures, an injurious effect upon the quality of the crops produced, then chlorine present in other components* of that manure will be equally injurious. It does not appear that potash in such compounds has a higher agricultural value than in the ordinary potassium chloride. This is all the more apparent when we remember that either sulphate or chloride of potash when added to most soils are very soon decomposed and the potash retained in some other form while both the chlorine and sulphuric acid unite with some other base, generally lime, and may be largely removed in the drainage water. For this reason potash salts containing considerable quantities of chlorine are frequently applied to the soil several months before the planting of the crop for which used.

As to the importance of a small amount of sulphur for crops there can be no question. It is probable that most soils contain sufficient available sulphurs to supply the needs of crops, at least such as can be grown without other manures. Organic manures, superphosphates, and most mixed fertilizers contain sufficient sulphates from other sources than potash salts to supply any deficiency likely to exist. And, besides, so far as known, there is no experimental evidence to show that the sulphates of the various bases applied as manures are generally productive of greater yields than the chlorides.

The true cause of the increased price of sulphate of potash in its pure form is its use for other purposes and its comparative scarcity. There are apparently no reasons why other and cheaper forms are not generally equally valuable for most agricultural purposes.

*As occurs in Kainit.

Some organic manures, such as tobacco stems and cotton seed meal, frequently contain considerable quantities of potash. The former of the substances mentioned sometimes contains as high as eight per cent while the latter contains about two per cent. The potash in this class of substances is of course made available only upon their decomposition. The action is, therefore, not likely to be as prompt as from the use of mineral salts.

Potash in unleached wood ashes exists mainly in the form of a carbonate. This, because of its strong alkalinity may be injurious to soil and crops if added in large quantities. It is soon decomposed in most soils so that its alkalinity does not last long and if not strong enough to injure the vegetation during the time it acts it may prove highly beneficial. Caustic lime, which is strongly alkaline, is often used with good results. A marked difference between it and carbonate of potash is that the latter is much more soluble in water and hence more energetic in its action. The potash of the carbonate, once fixed in the soil is probably equally as beneficial as that from any other form.

Because of the ability of many soils to retain in insoluble compounds the potash added to them, so that little is lost by drainage, an excess applied in any given year over what the corresponding crop may utilize will largely remain for future use. The same occurs with phosphoric acid but, in many cases, not with nitrogen.

LIME.

Probably no other substance, except farm-yard manure, has been so extensively applied to soils to increase their productiveness as lime. Especially is this true in many of the farm districts of Great Britain, and in some parts of the

continent of Europe. Its use has frequently proved of considerable value. That it does so by producing more rapid decomposition or other changes in the soil rather than by bringing to it the elements of fertility appear not only from our knowledge of the elements of plant growth and the conditions in which they exist in the soil, but also from the practice of many land owners of England to prevent by contract the use of lime by their tenants. To be sure, a certain amount of lime is necessary to the growth of all plants, but the general experience seems to be that it is not foremost among the elements of fertility that may be profitably added to soils. As an element of plant growth, its addition seldom becomes more important than the addition of phosphoric acid, and when this addition takes place, sufficient lime almost always necessarily accompanies it. So, too, the amount usually added when applied by itself is far in excess of that which enters into the structure of plants growing upon the soil, even for many times the number of years during which its effect is apparent.

Lime may be useful for correcting the acidity of certain soils. Being strongly alkaline in its nature it will combine with certain acids of the soil which frequently occur in wet, boggy places, and the presence of which are injurious to plant growth. So, too, it will decompose certain sulphates of iron, an injurious excess of which frequently occurs in lands similar to those above mentioned. In cool climates, where partially decomposed organic matter tends to accumulate to an undue extent, lime will be beneficial in hastening the decomposition. There is apparently little need of its use for that purpose in this State. Lime is also thought to decompose certain minerals of the soil, whereby certain other ash elements are made available to plants. It also, in the form of a carbonate assists certain important processes in the soil. Lime improves the physical condition of light land, either

by filling spaces between the particles, or by uniting chemically with them to bind them together, probably both. It also mellows heavy clay, causing it to be easily pulverized when dry, when otherwise it would form a hard mass. Draining and lime together will greatly improve such soils.

Lime is applied either to meadow land, or generally before plowing for other crops. It cannot well be applied with organic substances and fertilizers containing ammonia, unless precautions are taken to prevent loss. In case of slowly decomposing organic manures such loss would be largely prevented by thorough mixing with the soil.

The amount of lime used seems to vary greatly, not only with the purposes for which used, but often with the opinions of different farmers when used under apparently the same conditions. For frequent applications, from thirty to forty bushels of shell lime per acre have been recommended. When it is desired to change materially the physical condition of the soil, much larger amounts must be used. As permanent injury may result from an over-dose of lime, the inexperienced should use it with caution.

The chief natural materials which serve as a source of lime for applying to land are limestone, chalk and marl. In all these the lime is in the form of a carbonate. The former of these substances, and in some cases the others are in too compact a condition to be used without pulverizing. The most ready means for this purpose is that of burning and afterwards slaking with water. The lime thus prepared is more caustic, more vigorous in its action, and is in many cases preferred to the carbonate.

CAUSTIC OR SHELL LIME. This is the form the carbonate assumes after being subjected to a high heat. The carbon dioxide is driven off. The calcium oxide remains.

It is the form in which lime is bought for building purposes. It is usually in a hard, rocky condition and is very caustic. Usually it is not spread upon the ground until slaked.

HYDRATED OR SLAKED LIME. When water is added to caustic lime it is absorbed with great rapidity and with a giving off of much heat. A new chemical compound is formed called *calcium hydrate*. If the slaking is properly done the lime will now be in a loose, mellow condition. When for use upon land, a favorite way of slaking it is to place a quantity of the shell lime in small holes in the soil at convenient distances and cover for a short time with a small amount of earth. Sufficient water will thus be absorbed from the soil and the lime will be ready for spreading in the course of a day. Care should be taken that it be not rained on before spreading.

Slaked lime, though still caustic, is less so than shell lime. As it remains in the soil, it gradually takes up carbon-dioxide and loses its caustic properties. It will, of course, combine with any other free acids which may exist in the soil, and may even combine with pure sand. It is slightly soluble in pure water.

AIR SLAKED LIME. When caustic lime remains exposed to the air it gradually takes up moisture and carbon-dioxide and falls to pieces the same as though water had been poured upon it. This mixture of carbonate and hydrate of calcium exerts on soils an influence similar to that of slaked lime but is milder in its action.

MARL. This is a mixture of considerable quantities of carbonate with clay, sand or mud and is gererally the remains of shell-bearing animals such as clams and snails. Its value depends mainly upon the amount of these shells or the carbonate of lime it contains. It is usually readily pulverized or

becomes so upon exposure in heaps upon the ground during freezing weather. Its action is similar to that of slaked but is even much more mild than air-slaked lime. The sand and clay which it contains may assist in improving the physical condition of the soil but it is doubtful if it can be largely used for that purpose in this state at the present time. Land is as yet too plentiful and cheap to make it seem profitable to resort to such laborous means of improving it. As with lime the amount of marl to be used depends upon numerous conditions. Another important one must here be taken into account, namely, its purity. This differs with nearly every deposit.

GYPSUM, *land plaster*, or *sulphate of calcium*. This article is largely used in certain portions of this country mainly to encourage the growth of clover. It is also used with varying results, generally slight, upon corn and some other crops. In some of the regions above referred to it is believed by many that clover cannot be successfully grown without it. That it is highly beneficial to clover is often illustrated upon fields on which it has been carelessly sown the result being alternate streaks of poor and good growth.

Much discussion has been raised over the probable cause of the beneficial effects of this article. It contains two of the necessary materials for plant growth but its beneficial effects cannot generally be ascribed to this cause. There is reason to believe that gypsum causes the decomposition of certain compounds containing potash, whereby it, and perhaps some other bases are made available for the use of crops—the lime taking the place of them in the compounds decomposed—the sulphuric acid combining with them to form salts soluble in water. Admitting this to be the action, it tends to impoverish the soils to an extent far greater than is brought about by the use of most other manures. It is slow in its action and it is possible that its use might profitably give way to kainit and other salts containing potash.

Plaster for clover is usually sown broadcast early in spring. A dressing of seventy pounds per acre is amply sufficient for this climate. It is sometimes useful in composts (which see) and about stables where a little of it scattered will prevent the escape of ammonia fumes.

Gypsum beds of good quality are reported to exist in Pike County. (Ark. Geol. Rep. Vol. II, 1888.)

ASHES.

Ashes owe their value as a manure to the supplying of valuable elements of plant growth, to their ability to favor certain chemical changes in the soil and to their suitableness to improve by mechanical means its physical condition.

WOOD ASHES. The composition of wood ashes varies greatly with the kind of wood from which they are formed and the amount of impurities, such as sand, charcoal and moisture which they contain. An average of 116 analyses of various kinds of wood ashes, by the Massachusetts Agricultural Experiment Station, gives of acual patash soluable in water 5¼ per cent and of total phosphoric acid 1¾ per cent. Unleached hardwood ashes when free from dirt often contain a much larger per cent of both phosphoric acid and potash. Aside from these substances, ashes usually contain calcium carbonate sufficient to amount to half their weight or more. This article here serves the same purpose as in marl or chalk while the highly alkaline nature of the potassium carbonate which unleached ashes contain make their action upon the soil very similar to that of caustic lime. One difference in the action, however, seem to be that there is much more danger of applying an excess of ashes than of lime. On certain heavy soils which even very large quantities of lime make more easy to work the application of ashes in

large quantities cause the land to become hard and difficult of cultivation. This result is believed to be brought about by a chemical action of the potassium carbonate upon the soil whereby it is in a measure cemented together. Because such soils are more likely to be benefited by an application of potash and partly because they are more apt to be improved by the mechanical action shortly to be described, ashes are most suitable for sandy or gravelly soils.

In considering the capillary power of soils it was noted that the finer the particles and consequently the finer the pores between them the greater will be the capillary power of the soil. Wood ashes are generally in a very finely divided condition, and are found to be very retentive of moisture, either when by themselves or when mixed with earth. When applied in considerable quantities they are found to increase to a marked extent the capacity of the soil not only for retaining moisture, but for bringing it up from the depths below.

LEACHED WOOD ASHES. Ashes after ordinary leachings contain about one per cent of potash and about one and one-half per cent of phosphoric acid, there being generally a larger proportion of moisture than in the unleached. Their action on the soil is similar to that of the unleached, except such as is due to the potash and its strong alkalinity. They are milder in their action and can safely be applied in much larger quantities than the unleached.

Ashes from lime and brick kilns are similar to other ashes from the same fuel, but usually contain a larger per cent of impurities.

COAL ASHES. These, in distinction from wood ashes are nearly or quite worthless. They contain little or no valuable fertilizing material, as will be seen from the table below.

Finely sifted coal ashes might serve to improve the capillary condition of soils, but it is doubtful if they can often be profitably used for this purpose.

COTTON SEED HULL ASHES. These serve as a valuable source of potash. They are shipped largely from the South to the New England States to be used as fertilizers, which argues strongly that they can be profitably used at home. The reported average of forty-nine analyses made by the Connecticut Experiment Station, of this article shipped to that state for sale, is 22.84 per cent of potash soluble in water, and 8.61 per cent of total phosphoric acid. Of the phosphoric acid present, more than seven-eighths was found to be in an available condition. The varying composition of these ashes due to impurities is noted. The maximum potash found was 32.8 per cent, the minimum 10.4 per cent. Maximum phosphoric acid 11.7 per cent, minimum 3.7. Dr. Jenkins, in the paper* from which the above figures were taken, says, concerning these ashes in general: "At from $30.00 to $35.00 per ton they are a very cheap source of potash." Parties in buying these ashes will do well to note with care the proportion of coal cinders and other impurities present, and act accordingly.

As in wood ashes, the greater part of the potash here exists as a carbonate. Little chlorine is present, and these ashes serve an excellent purpose in growing tocacco. As compared with wood ashes, they contain but little lime. As these ashes are produced in considerable quantities in this State, a complete analysis made at the Connecticut Experiment Station is given below, showing the solubility of cotton hull ashes:

*Report Connecticut Board of Agriculture, 1890, p. 95.

	Soluble in Water.	Insoluble in Water.	Total.
Potash	25.20	2.65	27.85
Soda	.50	.80	1.30
Lime	None.	5.23	5.23
Magnesia	.20	11.04	11.24
Oxide of Iron and Alumina	None.	1.64	1.64
Phosphoric Acid	1.52	8.29	9.81
Sulphuric Acid	2.32	.09	2.41
Chlorine	.21	None.	.21
Carbonic Acid	8.28	3.31	11.59
Silica, Sand and Earth	.16	9.34	9.50
Moisture			19.29
Total	38.39	42.39	100.95

COMPARISON OF DIFFERENT KINDS OF ASHES.

	Unleached Wood.	Leached Wood.	Hard Coal.	Soft Coal.	Cotton Seed Hull.
Analyses, where made	Mass.	Conn.	Mich.	Mich.	Conn.
Potash soluble in water	5.5	1.1	.20	.10	22.84
Total Phosphoric Acid	1.9	1.5	.14	.05	8.61
Lime	34.3	28.5	5.00	2.50	
Magnesia	3.5	2.7			
Insoluble in Acids	12.9	13.8	82.00	94.50	
Moisture	12.0	31.1			

The phosphoric acid in the cotton seed hull ashes was as follows:

Water soluble	1.19
Citrate soluble	6.22
Citrate insoluble	1.20

A fair average value of unleached wood ashes would be about $8 or $10 per ton and of leached about $3 per ton. Ashes are especially useful for small fruits and orchards and when applied with care are a useful dressing for grass lands. They may be applied broadcast, with shovel, at the rate of about one ton or thirty-five bushels per acre. The amount to be used varies somewhat with the quality of the ashes, the nature of the soil and the purpose for which applied. No farmer should waste his ashes unless he has by careful trial

found them to be worthless as a manure. Ashes may serve a useful purpose for composting with bones as described elsewhere. If mixed with ammonia salts or organic matters rich in nitrogen they are likely to cause loss of that valuable substance.

BONES.

Large quantities are annually used in one form or another for manurial purposes. They owe their fertilizing properties mainly to the nitrogen and phosphoric acid which they contain. As found in the markets they differ considerably in their composition. The average result of 106 analyses, made by the Massachusetts Experiment Station, was 4.12 per cent of nitrogen and 23.5 per cent of phosphoric acid.

The usual form in which bones are put upon the market is that of ground bones or bone meal. The rate of decomposition of bones in soils depends largely upon the fineness with which they are ground.

RAW BONES. This term is used to designate ground bones made from bones not previously steamed or boiled. It is put upon the market under various names among which are "Ground Bone," "Bone Dust," "Bone Meal," "Bone," etc. These terms do not necessarily designate raw bone but are also applied to boiled and steamed bone. The raw bone of course contains all or nearly all the organic matter which bone in the natural condition usually contains. Because of this organic matter, especially the grease, the decomposition of these bones in the soil is often retarded. By steaming or boiling the bones this grease is largely removed but with it, frequently, a considerable quantity of the valuable nitrogen.

BONE BLACK OR "BONE CHAR." This is a refuse of cer-

tain manufacturing processes. All the nitrogen is driven off in the charing of the bone. Owing to impurities the phosphates present vary even more than in raw bones. Bone black is usually converted into dissolved bone or superphosphate before being used as a manure.

BONE ASH. This as the name implies is the mineral matter that remains after bones have been thoroughly burned. It contains no nitrogen but a good article will contain about 40 per cent of phosphoric acid. The commercial article is likely to contain somewhat less. Bone ash is exported from South America to a considerable extent, especially to England. It, also, is used in making superphosphates, but is in a better condition to be applied raw than bone-black.

DISSOLVED BONES OR BONE SUPERPHOSPHATE. To make more readily soluble the phosphoric acids of bones, and certain other substances to be noted later, they are often chemically decomposed by the use of sulphuric acid. Fertilizers thus prepared are known under the commercial name of "*Superphosphates.*"

When insoluble phosphate of calcium is brought in contact with sulphuric acid a part of the lime unites with this acid to form sulphate of calcium which is similar to the mineral "gypsum." The lime which remains, as a part always will if the article is properly prepared, forms with the phosphoric acid a phosphate soluble in water. Practically the insoluble phosphate is never all decomposed. This, or some other substance in the mixture, gradually unites with a portion of the water soluble phosphoric acid producing by chemical change a third phosphate which is in certain respects midway between the water soluble and insoluble phosphates. This phosphate is known as *reverted phosphate* and the acid of it as *reverted phosphoric acid.*

nures. This article generally decomposes rapidly in the soil. It is very variable in its composition. The better quality contains from 7 to 8 per cent or more of both nitrogen and phosphoric acid.

Cotton seed meal, castor pomace, oil cake (flax seed cake) and tobacco stems are frequently sold as manures. All contain greater or less quantities of nitrogen, phosphoric acid and potash. The first three of these substances are similar in their nature, being the residue of seeds after the oil has been expressed. They decompose readily and are especially valuable for the amount of nitrogen which they contain. Cotton seed are generally hulled before the oil is extracted. When not, the meal is known as *undecorticated* and is less valuable than the *decorticated*. Tobacco stems are especially valuable for the potash which they contain. Below are given some analyses showing the average relative composition of these various substances so far as manure constituents are concerned.

PER CENT NITROGEN, PHOSPHORIC ACID, AND POTASH IN CERTAIN MANURES.

	Nitrogen.	Phosphoric Acid.	Potash.
Cotton Seed	3.0	1.4	1.1
Cotton Seed Meal (Decorticated)	7.0	2.8	1.9
Cotton Seed Meal (Undecorticated)	4.0	1.7	1.5
Cotton Seed Hulls	0.9	0.2	1.2
Castor Pomace	5.3	1.7	1.0
Oil Meal (Flax Seed Cake)	5.6	1.7	1.2
Tobacco Stems	1.6	0.6	6.1

ROCK PHOSPHATES. In many places, both in the Old World and America, large deposits of rock are found which are peculiar for the large proportion of phosphoric acid, or phosphate of lime, which they contain. In America the

chief known deposits are in Canada and the Southeast United States. The phosphate rock of Canada is commonly known as *Apatite*. It is more difficult to utilize and is generally considered of less value than the deposits in the United States. Perhaps the most valuable of these latter deposits occur in South Carolina and Florida although they are also found in several of the neighboring states. These rock are sometimes ground and put upon the market under the name of "*Floats*." The phosphoric acid which they contain is in the form of an insoluble phosphate of calcium. When this rock is converted into a superphosphate by means of sulphuric acid it is known as *Acid Phosphate*. Floats and acid phosphate are both, like the rock from which made, exceedingly variable in their composition and should be purchased only when accompanied by a reliable guaranty stating the amount of phosphoric acid which they contain. In case of acid phosphate the three different forms in which it is present should be stated.

BASIC SLAG is a refuse from certain processes of iron manufacture in which the phosphoric acid which usually occurs in iron oars has been accumulated. It contains varying amounts of phosphoric acid in a condition from which it is supposed to be somewhat more available to plants than is that from untreated rock phosphates.

GUANO is a term originally applied to deposits on certain South Sea islands and coasts. These deposits were made up for the most part of droppings of sea birds. When situated in regions in which little rain occurred they contained considerable quantities of nitrogen as well as phosphoric acid. In other cases the greater part of the nitrogen had been washed away. The per cent and condition of the phosphoric acid contained was variable. These deposits have apparently for the most part been exhausted. Greater or less quantities of bat guano have heretofore been shipped from

caves in Texas to the New England States. Like all guano it is variable in its composition and should be purchased only when accompanied by a reliable analysis showing its contents.

POTASH SALTS. Various kinds of potash salts soluble in water are extensively used as manures. At present they have their origin for the most part in the salt mines of Strassfurt, Germany, where they exist in combination with other salts, especially those of soda and magnesia. Among these salts as found in the markets those richest in potash are the chloride (muriate) and sulphate. Kainit which is extensively used as a manure is a mixture of several salts. Its value lies chiefly in the potash it contains. Below is given the average per cent of potash and chlorine in the substances mentioned:

PER CENT POTASH AND CHLORINE IN CERTAIN LEADING POTASH SALTS.

	Potash, K. O.	Chlorine.
Sulphate of Potash	33.4	—
Chloride (Muriate) of Potash	51.5	48.8
Sulphate of Potash and Magnesia	23.5	2.6
Kainit	12.8	28.5

MINERAL NITROGEN MANURES. The most common mineral salts which are used as a source of nitrogen for manures are nitrate of soda and sulphate of ammonia. Of these the former is used most extensively. It is found as an earthy deposit in certain parts of Chili from which cause and its similarity to nitrate of potash (saltpeter) it is called Chili saltpeter. It is generally purified before shipment so that it contains little foreign matter. The commercial article contains about 16 per cent of actual nitrogen equivalent to about 97 per cent of pure nitrate of soda. The remainder is mostly water. Nitrate of potash is too expensive to be extensively used as a manure.

Sulphate of Ammonia is obtained largely from the manufacture of city gas. It is one of the most costly forms in which nitrogen is usually sold as a manure. It contains on the average about 20.5 per cent of pure nitrogen.

BARN-YARD MANURE.

Barn-yard manure usually refers to the droppings of domestic animals united with a greater or less proportion of straw or other litter. It is hardly necessary to say that it is exceedingly variable in its composition and nature, depending upon the kind of animal from which obtained, the nature of the food, the admixture of other substances, the protection from weather, etc.

Without going into details it may be mentioned in this connection that of the food consumed by animals, there is retained by them but a very small proportion of those parts of it which have been mentioned as being the most valuable in manures, namely, the nitrogen, phosphoric acid and potash. Practically none of these are so retained unless the animal is in a growing condition. While the carbon taken from the food is largely exhaled through the lungs as carbonic acid gas such of the nitrogen and ash material as may be taken from it are for the most part, generally after certain chemical changes of the substances in which they occur, discharged either as part of the urine or of the faeces. Of that most important part, the nitrogen, a considerable amount generally occurs in the urine in certain very readily decomposable forms. That part of the nitrogen in those parts of the food not digested by the animal remains in the faeces and is much less readily converted into plant food than that of the urea and other compounds of the urine. These latter compounds are readily converted into ammonia, the abundance

of which about horse stables is readily recognized by the odor. The animal, then, assists in returning the different elements and parts of plants to the condition in which they were taken up by the plant, and from which they were converted into plant matter. The same breaking down takes place outside of the animal body, generally through the agency of the lower forms of life—ferments and bacteria.

Farm-yard manure in the soil serves the same purpose then as the residue of plants which remain from year to year, and which every body who is familiar with the farm recognizes as being important to a rich soil. It is this which gives soils their dark color; the part which will be removed by burning. Because in such manure as usually applied, a considerable part of the plant matter is already partly decomposed—either through the assistance of the animal, the after-rotting of the manure or both—it is more readily active than would be a corresponding amount of fresh hay or straw. Still there are portions of it which are very slow of decomposition, of which fact we shall see the significance later. That portion which is most immediately active is in more or less soluble condition, so that when exposed to rains it is readily washed away. It is almost needless to say that it is poor economy to allow such waste to occur when it may be readily prevented, as it usually can by a little thought and care on the part of the farmer.

COMPOSTS.

The various waste animal and plant substances of the farm are frequently brought together in heaps suitably prepared to induce fermentation or decomposition of the substances, and yet retain their valuable manure constituents

against loss. Of these, phosphoric acid and potash will be lost only by drainage, which can be readily guarded against. The nitrogen is the most difficult to preserve. Aside from drainage, the two leading sources of its loss are by fire-fanging and by volatilization of the ammonia formed during the decay. The former may be prevented by keeping the mass well moistened and thoroughly compact to exclude air. Various devices have been recommended to prevent the loss of ammonia. Indeed, this is the prime motive of composting readily decomposable substances, such as animal refuse. One of the most readily obtainable substances adapted for the purpose is vegetable mould or rich loam. This is, too, perhaps as effectual as any substance. Flesh and other animal matters thoroughly interlayered with a sufficient quantity of this material will have the nitrogen retained in a form highly valuable as a manure, and if care is exercised no offensive odor will be given off. Swamp muck when obtainable is especially adapted for use in such composts. Not only does it retain the gases and other substances given off during the decay of the flesh, but it has a greater or less manurial value of its own. Swamp muck is not common in this state. Gypsum or land-plaster is sometimes added to composts to prevent the escape of ammonia. It exerts its influence only when the mass is in a wet condition. Kainit is sometimes used for the same purpose, and is said to give good results as well as being serviceable in the manure because of the potash it contains. Substances of a strongly alkaline nature, such as lime and ashes, set free the ammonia and cannot be used in ordinary composts. A small amount in composts containing much loam may not be injurious.

COMMERCIAL VALUATION OF MANURES.

In estimating the value of a high priced manure, three substances only are considered: Nitrogen, phosphoric acid and potash. These are all comparatively rare and costly. Other elements of plant growth can be obtained so cheaply in other material and are comparatively of so little value to the land that they are not taken into account in establishing the value of high priced manures, or manures having in them considerable quantities of one or more of the above mentioned substances. The commercial value of the three essential substances is given, then, with the understanding that there is a greater or less quantity of other matter united with them upon which, whatever agricultural value it may have in itself, no price is computed. For example, the price which a dealer charges for a phosphate is so much per pound for the phosphoric acid, with the understanding that the lime which is always combined with it shall accompany it free of charge.

The value of low priced manures, such as salt, plaster and barn-yard manure, can be sufficiently accurately judged without resorting to chemical analysis, and they are bought and sold with little reference to their commercial composition. With regard to high priced manures, that is, manures which should retail at $10.00, $20.00 and upwards per ton, special care must be taken to guard the buyer against carelessness or fraud on the part of the manufacturer and seller. Some definite method of valuation must be adopted by which the buyer may be enabled to determine whether or not he is paying about what the article is worth, and the seller know that he is receiving the same. This valuation is, for the reasons before mentioned, based upon the nitrogen, phosphoric acid and potash which the article contains.

It is customary, either because of the law of the state in which the article is to be sold, or from his own will, for the manufacturer to put upon each package containing high grade manures, a printed guaranty, stating in per cent the relative amounts of such of the three above mentioned substances as the manure in the package contains. Farmers cannot afford to buy high priced manures unless such guaranty accompanies them nor unless there is reason to believe that the quality of the goods will fulfill the guaranty. Reliable manufacturers of mixed fertilizers compound their goods under the rigid control of a competent chemist and the contents of their packages will usually fulfill their claim. When such is not the case the only method of ascertaining it, is by chemical analysis. Such analyses are usually made for farmers by those who have charge of the State Fertilizer Inspection.

G. L. TELLER.

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AGRICULTURAL EXPERIMENT STATION,

FAYETTEVILLE, ARK., Dec. 10, 1893.

To his Excellency, W. M. FISHBACK,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Sixth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

R. L. BENNETT,

Director.

University of California.
COLLEGE OF AGRICULTURE.

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FINANCIAL REPORT.

AGRICULTURAL EXPERIMENT STATION

AT THE

ARKANSAS INDUSTRIAL UNIVERSITY.

In Account with the United States Appropriation.

1893. **DR.**

To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1893, - - - - -	$15,000.00

1893. **CR.**

Salaries, - - - - - - -	$ 8,334.92	
Labor, - - - - - - - -	695.05	
Technical Apparatus, - -	49.52	
Chemical Supplies, - - -	304.35	
Seeds and Trees, - - -	140.69	
Printing and Mailing, - - -	1,023.40	
Freight and Express, - -	38.65	
Sundry Supplies and Expenses,	1,064.36	
Feed, - - - - - - - - -	122.05	
Live Stock, - - - - - -	180 00	
Building, - - - - - - - -	720.09	
Newport Sub. Station, - -	733.25	
Camden Sub. Station, - - -	782.47	
Library, - - - - - - -	42.63	
Miscellaneous Exp. and Ins., -	517.40	
Travel, - - - - - - - -	452.40	$15,201.23
		$ 201.23

The foregoing Statement is copied from the Experiment Station books which have been duly examined and found correct by the Auditing Committee of the Board of Trustees.

R. L. BENNETT,
Director.

REPORT OF DIRECTOR.

This report contains the published experiments and investigations, and the financial statement of the fiscal year ending June 30, 1893. Experiments and investigations have been continued in each division of the Station work upon questions of practical importance to farmers, fruit growers and stock raisers of the State.

The published work of the year is contained in five bulletins, and a full text of each appears in the succeeding pages. The bulletins are as follows:

Bulletin 20.—Animal Parisitism.—Some Texas Fever Experiments.

Bulletin 21.—Horticulture, Grapes.—Some Insects and Fungous Diseases and their Remedies.—Spraying Apparatus.—Apples and Grapes in Arkansas.

Bulletin 22.—Sorghum and Sugar Cane Culture.—Syrup and Sugar Making on Small Farms.—Some Field Experiments with Cantaloupes and Corn.

Bulletin 23.—Cotton.—Maintenance of Cotton Soils and their Improvement without Commercial Fertilizers.—Feeding Vegetable Matter to Cattle before using as a Fertilizer.—Importance of Seed Selection.—Injury to Lint by Ginning and Exposure to the Weather.—Classification of Varieties and the Culture of Each.—Avoidance of the Boll Worm and the Cotton Caterpillar.

Bulletin 24.—Fodder.—Explanation of Terms used in connection with Fodder Analysis.—Qualities which determine the Market Value of Hay.—Methods of securing Fodder from Corn, and the effect on the yield of Grain.—Composition and the yield of the Cowpea at different dates during the period from Flowering to Ripening.—Some further data upon the growth of the Cowpea, with special reference to the transfer of Dry Matter and Nitrogen from Roots, etc., to Peas.—The Fertilizing value of the Cowpea.

The lines of investigation, the experiments in progress, and a detailed report of Station affairs and operations have been previously reported to you and the Board of Trustees, and consequently they will not be repeated here.

Much important miscellaneous work aside from experimental work is performed by the Station staff that does not appear in the succeeding pages and deserves mention. The most important of that work is that of writing replies to requests for information on special subjects. A great many inquiries are received and questions asked upon all manner of agricultural subjects. Some letters contain many and lengthy questions, and much time is required to answer them. The number of those inquiries is increasing, and that is one of the best indications of the Station's increasing usefulness to the farmers.

The establishment of the Branch Station at Camden, in the southern part of the State, was an exceedingly wise provision for increasing and extending the Station's usefulness The Station there has been fully equipped this year and will do experimentation that will be of value to that section and to the State. The people there have manifested much interest in the Station and have shown every disposition to encourage and assist it in every way. The State is divided by soil and climate into three agricultural divisions—Southern, Northeastern and Northwestern. The spring season is three weeks earlier at the southern station than at the northeastern station, and five weeks earlier than at the central station in the northwestern part of the State, so it is important that agricultural experimentation, to be useful to the entire State, be done in each section as the Station is now prepared to do.

Each department of the Station and Sub-Stations are in good condition and active operation. The increasing number of requests for bulletins and for information and recognition by agricultural societies indicate that the Station is increasing in usefulness to the farmers, and that they are becoming more interested in its work.

The bulletins are now sent regularly to 9,500 farmers, and it is known by the revision of the mailing list that all to whom bulletins are sent desire them.

Parasitism of Domesticated Animals.

R. R. DINWIDDIE.

The subjoined brief descriptions of certain animal parasites and the troubles which they occasion, are given in answer to inquiries which have been received, and on account of the need of a better understanding among farmers and stock raisers of animal parasitism in general, and of those parasitic affections especially, which are most prevalent in their own localities.

Only a few of those which appear to be of most common occurrence, or of most importance in this State, are here referred to.

"Liver Rot" of Cattle. For a more complete description of this morbid condition of the livers of cattle, the second annual report of this Station, 1889, may be consulted. Such additional facts as have been established since that was written are here given.

Originally found in St. Francis, Monroe and Lee Counties, it has since then been found to occur also in Miller, Sebastian, Craighead, Sevier, Crawford, Franklin, Garland and Arkansas Counties. In some of these localities very few cattle are thus affected, while in others nearly all are found to be invaded by these parasites of the liver. These regions correspond more or less closely with the overflow districts along the rivers. The diseased condition of the livers of cattle well known to butchers in such districts, but often unknown to stockmen and farmers there, is caused by the presence in the liver of comparatively large, flat worms, commonly known as "Flukes." The life-history of a species (*Fasciola Hepatica*) nearly allied to this which occurs in Arkansas, was given in a previous report, and it is probable that our species goes through a somewhat similar course of development.

So far, this "Liver Rot" has only been reported as oc-

curring, to any extent, in Texas and Arkansas on this continent. If, as is claimed, it is identical with the *Distoma Magnum* described in Europe, its hosts, so far as known, are only cattle and certain species of deer. In the previous report, referred to above, it was stated that this parasite was likely to prove a serious obstacle to the raising of sheep in those districts in which it was found in cattle. Further investigation, however, has convinced me that this was an error. My own observations at the slaughter houses in such districts, as well as the testimony of butchers there show that sheep do not suffer to any extent, if at all, from this liver fluke. I have never found it in sheep, whilst the common liver fluke reported in Texas sheep* seems also to be either unknown or extremely rare in Arkansas.

The life history of the Arkansas liver fluke has been, and is now, under investigation, but no results can yet be reported.

Stephanurus Dentatus. (Lard worm.) This parasite is found within the abdominal cavity of hogs, in the fat around the kidneys, in the substance of the kidneys and liver and occasionally in other parts of the body. It is a round worm attaining a maximum length of less than two inches and usually of mottled appearance. Reference is made to this parasite here on account of its occurrence in the livers of hogs almost universally throughout the State. There are but few counties in which it does not occur more or less, and in many of the central and southern counties, butchers inform me that the livers of the hogs they kill are never fit for use. Other species of parasites have also been found, but by far, the most common cause of this trouble is the species here referred to. Whether or not these parasites are partly responsible for the great fatality which prevails almost constantly among hogs in the central and southern counties of the State is uncertain, but it is not unlikely that such is the case. The biology of the "lard worm" has not been dem-

*Bulletin No. 18, Texas Agricultural Experiment Station.

onstrated, but it is supposed that hogs become infected with the water which they drink, a theory which may explain the extreme prevalence of the parasite in this State.

To diminish the extent of this form of parasitism, no more practical measure can be recommended with our present knowledge than that more care should be taken to supply hogs with pure water, especially well water. They should be kept on dry, rather than on marshy pastures, and not confined year after year on the same ground. These rules apply not only to this, but to nearly all forms of parasitism in animals.

Hog Itch or Scabies. (*Sarcoptes scabiei* var. *suis.*) A number of inquiries have been received for information as to the cause and remedy for skin diseases affecting hogs. From the symptoms which have been given, and from examinations which have been made of several affected herds, it is believed that the above disease is that which is mostly complained of. It is a contagious affection of the skin caused by the presence of the hog variety of the mange or itch insect.

Symptoms. The trouble is first manifested by the animals rubbing the affected parts. It usually begins on the head and face, and later spreads to the limbs and body. Reddish pimples are first formed, which later give place to thick scabs; the skin from rubbing becomes swollen and fissured or abraded. When the whole body becomes invaded, it interferes very much with the fattening propensity of the animal, and young pigs not unfrequently die from it. The parasites can sometimes be readily found and seen with the naked eye, but very often they can only be found with difficulty, and by the aid of the microscope. However, the symptoms given above, together with its manifest contagiousness are sufficient to indicate the disease.

Prevention and Treatment. In the way of prevention, it is important to know the two methods by which a herd

may become infected; first, by contact with other hogs similarly affected, and second, from occupying pens or lots recently occupied by such hogs. (The disease is communicable from hogs to man; also to dogs and probably other domesticated animals*, but the infection in such cases is usually temporary and probably rarely occurs.

It is therefore necessary for the farmer to prevent his hogs from mixing with his neighbors' when any such skin disease prevails. The custom of allowing hogs to roam on the roads at will tends to the spread of this and other contagious affections.

The eradication of scabies from the stock of a farm after it has attacked a number of animals is a task of considerable labor and time, as each animal has to be handled separately. The following is the method which should be adopted: Prepare lots or yards where those affected have not had access to, and into one of these or into a previously unoccupied pasture put those which are yet unaffected.

The diseased should be well scrubbed with soft soap and water by means of a rough brush and the remedy then applied. A common remedy in the West for scab of sheep, Texas Itch, etc., can be used to good effect here. It consists of sulphur and lime in equal parts boiled in about twenty parts of water. It should be thoroughly applied on the affected parts and over the whole body if necessary.

When treated turn the hogs into a fresh lot by themselves and repeat the application in ten days. Hogs should not be allowed in the fields or lots which they previously occupied for at least one month. Pens, troughs, etc., should be either disinfected or cleaned and left unused for a considerable time. It is uncertain just how long such places remain infected, that is, how long the acari or their eggs retain vitality under such conditions. It has been put at one month. (Neumann.)

Improved breeds seem to suffer more than natives. Fil-

*Neumann *Traite des Maladies Parasitaires.*

thy surroundings and insufficient food and shelter, by diminishing the resisting power of the host favor the propagation of these parasites.

Cattle Ticks (Boophilus bovis, Curtice; *Ixodes bovis*, Riley). These parasites are well known to stockmen in the South, being found on cattle coming both from the prairies and wooded regions of the Southern States.

Cattle may be invaded to some extent by various species of ticks which have for their more common host some other species of wild or domestic animals, but on Southern cattle these are rare compared with the immense numbers of the species named above, the true cattle tick, by which they are often covered.

Specimens of cattle ticks have been obtained by me during the past two years in large numbers from various parts of Arkansas (Fort Smith, Little Rock, Texarkana and Brinkley), and from Indian Territory, Mississippi and Louisiana. With the exception of a very few specimens obtained early in the summer at Texarkana, Ark., these were all of the same species, and, I believe, identical with those which occur on Texas cattle, although from lack of specimens from that State I have not been able to verify this point.

Ticks are found, often abundantly, on cattle in the central and southern counties of Arkansas. In the northern counties they appear to be rare. Those few specimens obtained in this neighborhood (Washington County), do not belong to the same species as those of the South. Ticks have been said to occur also on cattle of the Northern and Western States. Of this I have no knowledge, personally, but imagine, if such be the case, that they are not of the same species as the Southern cattle tick. In this State, at least, the regions in which cattle ticks occur, correspond closely with the regions permanently infected with Texas Cattle Fever. The significance of this statement will appear later in this report.

Life-History. The life-history of the cattle tick is as follows, all scientific technicalities being omitted: They are found on cattle in this State early in summer, very few before the first of June. Further south they appear earlier. Cattle become invaded two or three weeks before the ticks become visible without examination directed to that end. Mature female ticks, those large bloated objects with which Texas cattle are often literally "shingled," may be seen on cattle in this State in the month of June, usually in small numbers at this season. They drop to the ground when mature, either by withdrawing their toothed rostrum from the skin, or by leaving it in the skin of their host. On the ground they seek a sheltered spot beneath thick, matted grass, or often beneath masses of dried cattle manure and proceed to the deposition of their eggs. This occupies two weeks or more, longer in cool weather than in hot, each tick laying an immense number, from two to four thousand eggs. Ticks which have been picked from cattle before maturity, before they have attained one-third the dimensions of the fully swollen specimens, after some delay, also deposit eggs in correspondingly smaller numbers. For the incubation of the ova all that is necessary is a summer temperature and shelter from the sun. Under direct sunshine they shrivel up and fail to develop. A certain amount of moisture, such as may be derived from the soil, favors incubation but is not indispensable. The time required for the hatching varies according to the temperature. According to observations of this year, under natural conditions the ova hatched out in twenty-five days from the first appearance of the eggs in the months of June, July and August, twenty-nine days in September, and six weeks in the latter half of September and October. By artificial incubation this period may be reduced at least one week. The young are very small, and unlike the adult females, are very active. They distribute themselves in the grasses and weeds in their neighborhood, waiting until the opportu-

nity occurs of transferring themselves to cattle. In this larval stage, if no host presents itself, they are capable of living a long time apparently without food and without undergoing any further development. I have kept them alive in glass dishes in the laboratory in this larval condition for four months (Oct. 7th to Feb. 12th). They are benumbed by cold, but are not killed by at least one night's exposure to a temperature of 28° Fah. It is probable, therefore, that if the opportunity of beginning a parasitic existence does not occur, these larval ticks may live all summer on the pastures or lots on which they have originally been hatched out. Unless they do find a suitable host they will ultimately die without propagating themselves. They can live and develop, to some extent at least, on other animals than cattle. On man they will grow to six or eight times their original size, but here I have never seen them develop beyond their larval or octopod stage. They do not adhere to rabbits which have been sprinkled with them. On the horse, however, cattle ticks can probably develop to maturity. This was shown by a test made last year, where, of a number of young ticks sprinkled on the head, face and neck of a horse on Oct. 14th, a few had attained apparently their adult state (though not swollen up as on cattle) by Nov. 10th. Ponies also, just arrived from Texas, are frequently seen with ticks on their bodies, which are said to be identical with those on cattle. At any time after hatching, these young ticks are in condition to begin their parasitic existence. When placed on cattle, they develop to their full adult condition in about four weeks. The shortest period I have observed is twenty-five days. During their development they moult three times.* In about a week they have much increased in size and can be felt with the fingers, but are not readily seen without careful inspection. After two to three weeks they become visible above the hair of the cattle at a few feet distant; their growth, however, seems to be uneven, some attaining matu-

*Curtice Jour. Comp. Med., Vol. XII., No. 7.

rity much sooner than others. The males never become large and swollen like the females. Except after moulting, the females seem never to change their position and probably seldom leave their original host, their whole life being spent upon the animal which they first invaded. This may be said to be the rule, but some observations which I have made during the past summer indicate that it is not invariably the case. (On putting cattle into pens which for two months had contained ticks and tick infested cattle, it was found that these newly introduced cattle did not later show the presence of ticks on their bodies at a stage of development further advanced than the larval stage could have attained during the time these cattle were exposed. In other words, they were invaded from the soil only by the young ticks which had not previously been on cattle. I noticed one instance in which this was not the case and another in which it was doubtful.) Full grown ticks which have voluntarily dropped from cattle, never again leave the soil. When forcibly removed the glossoid and toothed mandibles by which they adhere are left behind or brought away with a fragment of the skin firmly inclosing them.

The following is a sample table of the cycle of development observed this summer:

1892. June 24th.—Mature ticks and eggs partly deposited arrived from Baton Rouge, La.

July 8th.—Egg deposition completed.

July 21st.—Young ticks begin to leave shell.

Aug. 2nd.—Young ticks all out; placed on calf.

Aug. 27th.—Ticks fully grown and beginning to drop.

Sept. 1st.—Egg deposition begins (by ticks picked from calf Aug. 27-30).

Oct. 3rd.—Young ticks begin to leave shell.

Hatching in the above cases took place in the laboratory without artificial heat. Practically the same dates apply to

other cases in which the whole process took place in the fields. We conclude, therefore, that in this climate and under favorable conditions (especially the timely occurrence of the host), an adult tick, such as may be seen in June, will give rise to two generations of its kind before the advent of severe frost checks further propagation for that year.

The latest egg deposition I have seen here was in the month of November.

How is the species preserved during winter? In Northern States and in fact everywhere except in the "cattle tick region" winter seems to kill them out. Further south either the ticks or their eggs or both outlive the winter, favored by the mildness of the climate and probably also by the thick masses of withered grasses and brush common in the South, and under which they are sheltered.

I have dwelt at some length on the facts observed in the life-history of this parasite on account of the now well established relation which ticks bear to the disease of cattle known as Texas or Southern Cattle Fever. The facts bearing on this question will be shown in another part of this report.

Their Effects on Cattle. Ticks are usually considered harmless, but when in large numbers, living as they do on the blood of their host, we may well believe that by the mere abstraction of blood they will tend to debilitate an animal especially if the latter is already in poor condition.

I have observed in two cases in which many large ticks were present on the inner aspect of the limbs of young cattle the formation of hard painful swellings, but as a rule they do not seem to occasion much local irritation.

Prevention of tick invasion and the removal of these parasites when present, will require considerable time and labor when a large number of cattle are concerned. When the ticks have obtained a size at which they can be readily seen, the best method is to displace them by means of a curry-comb or rough brush, but care should be taken that all the

ticks are destroyed. Internal medication seems to have no effect in removing them. Sulphur and salt which by some farmers are considered as specifics for the removal of ticks have been tried without any appreciable effect.

As to local applications two preparations have been tested:

Tobacco Infusion made according to a formula often prescribed for scab in sheep was tested on several calves badly invaded by ticks of all sizes. They were thoroughly washed all over with the infusion on two successive days. When examined later it was found that all the small ticks were killed, those which had attained the size of a grain of wheat or larger did not seem to be in any way affected.

Pyrethro-Kerosene Emulsion. This preparation as well as the plain kerosene emulsion used as insecticides by horticulturists is now successfully applied to the destruction of lice and fleas on domestic animals. For this purpose it has no equal for cheapness, cleanliness, and efficacy. To prevent the invasion of cattle by ticks, I have recommended its use for the past two years, but from this source I have no data upon which an accurate conclusion as to its efficacy can be based.

During the past summer and that of '91 it was tested as to its power of destroying ticks on cattle. Used in an emulsion containing ten per cent of kerosene and the extract from two per cent of pyrethrum, it was found by repeated tests to have practically the same effect as the tobacco infusion. Young ticks, those under ten or twelve days old on cattle, were all destroyed by one application; older than two weeks and when about the size of a grain of wheat, they were not killed by repeated applications. It was not noticed that the addition of pyrethrum increased the toxicity of the emulsion for ticks, but an accurate comparative test was not made.

From these tests the following can be recommended as the most promising method of keeping ticks from cattle:

If already present and large enough, pick the large ones

off by hand or rub them off with the curry-comb, going over the whole body carefully and destroying all ticks thus removed. Then give the cattle a thorough and complete wash with kerosene emulsion or an emulsion of the kerosene extract of pyrethrum prepared according to directions given below, giving special attention to those parts of the body where ticks are mostly found.

Repeat this process at least once a week during the summer months while ticks are prevalent.

Fields which have not been occupied by cattle for at least one year are likely to be free from ticks.

The number of ticks on Southern pastures would certainly diminish with cultivation, clearing of brush, etc.

Stabling of stock, unless continuously kept up, would not give entire immunity.

Avoid turning cattle, which it is desired to protect, into fields with thick matted growths of old grass, much underbrush, or into those which have been much pastured by other cattle bearing ticks on their bodies.

Pyrethro-Kerosene Emulsion. (Prof. Menke.)

(1) Mix 1¾ lbs. pyrethrum in 1 gallon kerosene; after twenty-four hours decant the fluid.

(2) Dissolve 1 lb. soap in 1 gallon boiling water.

Remove the soap and water away from the fire, add the kerosene extract at once and mix thoroughly by means of a large syringe or force pump. Ten minutes mixing will form an emulsion.

This stock emulsion can be kept indefinitely. For use on cattle or other animals it should be diluted with four parts water, which gives an emulsion containing about ten per cent kerosene and the extract from two per cent of pyrethrum.

Kerosene Emulsion. (Prof. Cook.) Dissolve in two quarts of water, one quart of soft soap or one-fourth pound of hard soap, by heating to the boiling point, then add one pint of kerosene oil and stir violently for from three to five

minutes. This is best done by pumping the liquid into itself through a small nozzle, so that it shall be thoroughly agitated.

For use this can be diluted with about an equal volume of water.

About one-half to one gallon of the diluted emulsion will be required for each animal if put on with a cloth or brush.

Some Texas Fever Experiments.

During the past three summers, attempts have been made to determine the means or medium by which the virus of this disease is carried by Southern cattle, and by which they are thus enabled when shipped or driven North to cause often wide spread and fatal disease in Nothern stock, and often in this State in cattle only a few miles removed from their original home.

The conditions under which Texas Fever (or Southern Cattle Plague, as it is more appropriately called) occurs, having been described in previous reports from this Station, it is unnecessary to return to them here.

In 1889 (Second Annual Report, Arkansas Agricultural Experiment Station) it was shown that the grasses and surface soil surrounding the roots of the same taken from pastures which had proved very fatal to Northern cattle, did not produce any bad effects on susceptible stock to which they were fed in a dry condition.

It was also shown by my investigations in the summer of 1890, that the statements as to the constant occurrence of bacteria, the so-called germ of Texas Fever, in the blood and organs of all Southern cattle were incorrect, being evidently based upon results obtained by defective bacteriological technique.

This summer and that of 1891, our tests were confined to the two media which now receive the most scientific sup-

port as bearers of the Texas Fever virus, namely, the excretions of Southern cattle, and Southern cattle ticks. Pens were constructed for the purpose of testing these substances, some 36 feet by 24 feet, others 24 feet by 12 feet. They were put up on level ground and closely boarded in at the bottom, the lowest board being well sunk in the ground. The pens were separated from each other by a space of 12 feet and the whole inclosed by another fence at some distance from the pens in order to avoid the risk of spreading disease among stock outside.

The tests made were of a practical nature, and consisted in placing on the ground in some of these pens the excrement of cattle collected both fresh and partly dried, from pastures and in stables in Southern infected regions, and scattering on the surface of other pens, ticks picked from cattle of the infected regions of this and other States. In these pens, cattle purchased in this neighborhood were afterwards placed and kept during most of the summer, or until the experiment was ended. A modification of these tests consisted in scattering the cattle manure from the South on the hay, and thus introducing it into the stomach of the experimental animals, and of sprinkling the bodies of other cattle with young ticks hatched in the laboratory from eggs deposited by ticks sent from the South.

In the summer of 1891, four cattle were subjected to such tests; during the past summer the experiments were repeated on ten others.

Only such details of these experiments as are necessary for a correct understanding of their nature, and for an intelligent interpretation of the results obtained will be given here.

Tests of Cattle Manure, 1891 and 1892. August 17, 1891, cattle manure to the amount of about two bushels by measure, collected three days before on fields near Pine Bluff, Ark., was scattered on the surface of pen I. August

28th, a like amount obtained near Fort Smith was put in the same pen. This manure was not more than a week old when collected.

August 17, 1891, pen II. received about the same quantity of older cattle manure, also from Pine Bluff, and on September 5th, a further consignment of the same material from Little Rock.

August 17, 1891. On this date two cattle, eighteen months old, were placed, one in each of these pens and kept there until November 6th, or over ten weeks. Like all the others, they were regularly watered and fed hay and a small amount of grain. No regular record was kept of their temperature, as they never showed the slightest signs of sickness. The first frost occurred October 8th. The cattle improved in condition during their confinement.

These and all other cattle experimented with were susceptible to the virus of Texas Fever, being raised north of the "fever line," which, in this part of the State is south of the Boston mountains.

1892. Pen I. (which during the winter had been well cleaned out and exposed to the weather) received as in the previous year manure dropped by Southern cattle. This was received from Texarkana and Little Rock June 9th and 11th, and from Ft. Smith August 22nd.

August 2nd, two cattle, aged fifteen and eighteen months, were put into this pen and kept there until September 14th in one case, and October 14th in the other. A record of their temperature taken usually every alternate day was kept from August 17th, or fifteen days after their entrance, that being the usual time after first exposure before cattle show signs of sickness on infected pastures in the South. The general appearance of the cattle was observed daily.

In the tables appended to this report will be found the record of temperatures for all the cattle experimented with during this summer.

It should be said that while the regular temperature readings in such tests are of the greatest value from a diagnostic point of view, the judgment should be based not on this alone but also on the other symptoms presented during life and on the changes noticed on examination after death. Temporary rise of rectal temperature up to 104° F. in young cattle especially is not uncommon and does not necessarily indicate disease, but continuance of the temperature at this or a higher figure should be considered as due to some pathological condition. In this climate the average normal summer temperature of cattle under two years of age is about 102° F.

Of these cattle in pen I., that numbered 11 in tables, entered pen August 2nd (seven weeks after the introduction of manure). Beginning with August 26th the hay in this pen was sprinkled daily with manure soaked and broken up in water. On August 23rd a slight and temporary diarrhœa was noticed with a rectal temperature of 103° F. The calf at no time showed any further indication of sickness. The temperature as may be seen from the table varied considerably from day to day but showed no continued elevation. The highest recorded was 104.5° F. on September 22nd; the lowest 107.8° F. on September 1st. It was taken out of pen I. on October 4th and subjected to further tests in pen II. (See No. 22 in tables.)

Calf No. 12, also in pen I., never gave any evidence of ill health while subjected to the same test. Highest temperature 102.9° F. September 16th; lowest 101° F. August 27th. It was moved to pen III. on September 19th.

The result of these tests as to the virulence of Southern cattle manure on Northern cattle was considered negative.

Tests of Southern Cattle Ticks as Propagators of Texas Fever. 1891, August 28th. In pen III. (36 feet by 24 feet) were scattered on ground about two hundred living adult ticks picked from "Nation" cattle at Ft. Smith on previous

day; also on September 7th about the same number sent from Little Rock. The latter had commenced the deposition of eggs.

August 28th, two cattle, seven and one years old, were introduced into this pen. The older animal remained in it until December, but never became invaded by ticks. Only one tick was seen on it at any time and that was when taken out. The temperature taken at irregular intervals was always normal, and the cow did not appear to be affected in any way. The younger animal also apparently remained well and free from ticks up till October 14th, when it was thrown down and a large number of young ticks hatched out in the laboratory from eggs deposited by Southern ticks were sprinkled over its body. On the 24th, or ten days later, it was noticed to be indisposed to eat and from this date to the middle of November did not thrive as well as before, but no rise of temperature was recorded. A small number of ticks grew to maturity on this calf.

November 6th. Two other calves taken from pen I. and pen II. were exposed to the invasion of ticks in pen III., and on one of them a number of young ticks was sprinkled. Some of these ticks arrived at maturity one month later; on the other no ticks appeared. The weather from the middle of November became very cold, the mercury sinking to 12° F. on the 17th, so that nothing could be expected from such a test. These two calves showed no sickness.

October 12th. In pen IV. a two year old heifer was similarly sprinkled on the abdomen with young ticks. A few of these were observed fully grown on this animal November 9th. She was too wild to allow of the temperature being taken, but seemed to remain in good health throughout.

1892. Further tests were made of the action of Southern cattle ticks on Northern cattle in pens II., III., IV. and V.

Pen III. received mature ticks sent from Baton Rouge, Louisiana, June 24th; from Agricultural College, Mississippi,

June 28th and August 21st, and from Little Rock, Arkansas, August 9th. There were confined in this pen during the summer for various periods and entering it at different times, eight cattle. Of these, six developed the symptoms of Texas Fever, none, however, in a fatal form.

The three first cattle tested entered pen III. about August 1st. All of these were found to have a high temperature on the 17th of the same month, which only returned to the normal after from two to three weeks. Two did not show marked sickness, and but for the use of the thermometer would hardly have been considered out of health. The third showed the disease more plainly. It became weak, refused food and fell off very much in condition. Two of these three cattle were examined after death (killed for examination), and showed lesions indicating a mild attack of Texas Fever.

In the second test, made in the same pen, five cattle were introduced during the first and second weeks of September. These were also sprinkled with young ticks hatched out in the laboratory, and all became considerably infested by these parasites. Four of these became very sick within a month after entering the pen, and about three weeks after sprinkling with young ticks. The temperature in these calves began to rise about a week before they showed any distinct signs of sickness. They became very weak, refused all food, and could not be made to rise without lifting. When on foot they walked with a staggering gait; the head was held near the ground, and the breathing was rapid and panting; in fact, they showed plain symptoms of Texas Fever. The urine in none of these became dark or red colored. After reaching its height the fever gradually subsided to near the normal, but the calves continued for several weeks in a very unthrifty condition, with poor appetite, languor, and weakness. During this convalescence, the morning temperature would indicate one or two degrees of fever (in one case it fell below the nor-

mal), while in the evening there would be a rise of three to four degrees, or more.

The cow, which did not show fever—an old and feeble animal, suffering from a malignant tumor at the root of the ear—became enormously infested with ticks and died apparently from pure debility.

One of the calves plainly showing the disease was a three months old suckling.

Pen IV. In this pen no ticks were put on the ground. A fifteen months old calf was put into it on August 2nd and on the same date it was sprinkled with young ticks, the progeny (hatched in laboratory) of several adult ticks obtained at Texarkana, Ark., early in June. These were not of the same species as the common Southern cattle tick. (Species undetermined.) Two days later these young ticks, now several times increased in size, were seen in considerable numbers adhering to the body of the calf, but they all disappeared in a few days. This calf remained well during the test of twenty days.

In pen V. another calf of the same age was sprinkled with the young of Louisiana ticks, and raised a fair crop of these. It suffered from a mild attack of fever, only distinguished by the thermometer.

A Test of Ticks of the Second Generation. In order to discover if this now well demonstrated fever begetting or propagating property of Southern cattle ticks was a permanent property of these parasites, when removed from their native home, a test was made of the second generation of young.

Young ticks of the first generation from those sent from Louisiana and Mississippi placed on cattle here during the first week of August, reached their full size about the last of the same month. A number of these were picked off the cattle, put in a suitable place in the laboratory, and in a few days egg deposition commenced. At natural temperature the

young were hatched out in four weeks, and on September 29th and October 1st, a large number of these were put on the body of a healthy four year old cow, which was then confined in pen II., previously unoccupied. The cow became manifestly sick on the 11th; that is, twelve days after being thus treated, and died on the 13th, with all the symptoms of an acute case of Texas Fever. Examination after death showed the typical lesions of this disease.

October 4th, an eighteen months old calf, which had been exposed to cattle manure for two months in pen I., without effect, was put in the same pen II., and similarly sprinkled with young ticks of the second generation from those received from Mississippi. It became sick October 12th, with a temperature reaching 106.7° F., refused food and became very thin, but ultimately recovered.

Summary. It is seen from the foregoing experiments that the theory which imputes to the dejections of Southern cattle the blame of conveying disease to Northern stock is not sustained by these practical tests. On the other hand, there is abundant evidence of the very important part which cattle ticks play in the production of this Southern cattle fever.

The credit of first experimentally testing and affirming this connection of cattle ticks with Texas Fever is due to Dr. Kilborne (Rep. Bureau of Animal Industry, 1890). The results of this and later experiments of the same kind by the Bureau of Animal Industry are confirmed by the experiments here recorded, so far as the agency of the tick is concerned.

Without assuming too much from this now established fact, a perusal of the experiments given in this report, taken in conjunction with the life-history of the cattle tick, will show that we have here an all-sufficient means of explaining the peculiar features of this disease as it occurs on Northern pastures.

It is shown that the progeny of Southern cattle ticks when they invade Northern or susceptible cattle in summer,

almost invariably give rise to Texas Fever in these cattle; an unbiased study of the literature on this subject equally shows that no other means by which this disease, under natural conditions can be transmitted, has been satisfactorily demonstrated.

That the infection in the cases here recorded was produced by a process of inoculation of cattle by ticks, and not indirectly by microbic infection of the soil, is indicated by the constancy in the time at which fever appeared after the cattle were sprinkled with ticks, and by the fact that in no cases was any fever noticed without the presence of ticks on the body.

The disease exciting power of ticks is not confined to the first generation of those from the South, but exists with equal virulence in the second generation bred in the North. Cases 21 and 22, in pen II., show that fatal secondary infection by Northern cattle can easily occur in this latitude, and in fact, anywhere in the United States. The time which elapsed between the cases of fever induced by successive generations from the same ticks was fifty days (August 17th to October 9th), the only departure from the natural conditions being that the ticks were put on the cattle instead of the latter being invaded from the ground.

From this we may infer that if a first outbreak of Texas Fever occurs as early as two months before the usual advent of freezing weather in that locality, Northern cattle which have recovered from a mild attack, (and the number of these is doubtless much larger than has been hitherto supposed) are likely to be responsible for outbreaks later in the year. They become, if carrying ticks on their bodies, walking centres of infection, just the same as Southern cattle, and there is no doubt, if the history of the hundreds of cases of Texas Fever which occur every summer in those States bordering on the proscribed regions were more accurately traced that this secondary infection could be frequently demon-

strated. In this way the disease may be carried to places where Southern cattle have never been.

As to Quarantine. It is evident from the foregoing, that when Southern cattle have found their way to non-infected regions any time before September, quarantine should include both cattle and fields or roadways on which they have been. The cattle should be quarantined for a period of four weeks at least (from the date on which they left infected ground). Unless intended for slaughter within two weeks, quarantine should not exceed six weeks. Fields, roads, etc., should be quarantined till late in the fall. If this is done, the infection is confined to its original limits, if not, it may be distributed far and wide.

On those cattle which die from acute cases of Texas Fever produced by ticks, these parasites are often found not larger than the size of a grain of wheat, that is, not more than from two to three weeks old on their host. I have always observed that these half grown ticks do not leave cattle on the death of the latter, but remain adherent to the skin until they also die. Hence, such acute cases cannot spread the disease by the agency of the ticks which are on them.

Texas Fever in Arkansas. In the northern counties, deaths from this cause occur by far the most frequently among town cows. Farmers who keep their stock confined on their own farms rarely lose cattle from Texas Fever. This, I have found to be the case in most of the outbreaks which have been investigated, and it is also indicated by the correspondence which I have had with those counties, chiefly Cross, Independence and Cleburne, where many cattle have died from this cause during the past summer. The original center of infection in these cases may be from cattle driven from further South, but far more frequently it is to be found along the unfenced railway tracts, especially near the depots where stock cars are often delayed. Later in the fall the infection may be widely distributed from this original center.

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In the central and southern counties, Texas Fever occurs in a severe form only in imported cattle, native cattle acquiring immunity by one or more mild attacks early in life. Even suckling calves of three months are not exempt from the disease (see case 35 in tables), but in young stock acute fatal cases are rare. (The only fatal case in our experiments was a four year old; all the others ranging from three months to two years recovered.) One attack, even of the mildest character, seems to confer immunity for that year at least. (Cases 32 and 42.)

While it is shown that ticks form at least the most important agent in the transmission of Texas Fever in the North, and perhaps the only one, it is not certain that this is the case in the South which may be called the home of the virus of the disease. Whether or not susceptible cattle could be protected on Southern pastures by thoroughly keeping off ticks remains to be tested. Bearing on this question is the fact that in one outbreak of Texas Fever at Fort Smith, occurring in March of this year, no ticks could be found on the bodies of those that died, even by the closest inspection.

For those who desire to grade up their cattle by importing improved breeds, the following rules, some of which are not new, may be suggested:

1. Buy cattle raised in the South, and hence already acclimated.

2. When Northern cattle are imported, let it be late in the fall, and let the cattle be under fifteen months old.

3. In the spring prevent the sudden invasion of these cattle by large numbers of ticks, by the methods already given.

NOTE—For part of the specimens and material used in the foregoing experiments this Station is indebted to the courtesy of Mr. I. M. Good and Prof. Tait Butler, Agricultural College, Miss., Prof. W. H. Dalrymple, State University, Baton Rouge, La., and Dr. A. E. James, Little Rock, Ark.

General Condition of Live Stock in Arkansas During the Year 1892.

From reports of correspondents in most of the counties of the State it appears that, with the exception of hogs, live stock in this State has been in a generally healthy condition during the year. Hog cholera has been reported in about three-fourths of the counties heard from, the greatest losses from this cause being in the central and southern counties. Scabies or other skin diseases of hogs has prevailed in a few counties.

Sheep are reported to do well in all except ten counties, these being chiefly in the southern part of the State and along the Mississippi River. They are raised only in small numbers and receive little attention anywhere, the lack of a "dog law" being, from all reports, the great obstacle to what otherwise might be a profitable industry in Arkansas.

Glanders in horses and mules has been investigated by the Veterinarian or reported to him in the following counties: Craighead, Ashley, Grant, Drew, Pulaski, Cleveland, Sebastian, Lonoke, Sharp and Fulton.

Texas or Southern Cattle Fever has prevailed in Lawrence, Cleburne, Cross, Independence, Sebastian, Carroll and Washington Counties. In Sebastian County the losses occurred in northern cattle imported there for feeding; in the other counties mentioned the disease prevailed among native stock.

APPENDIX.

TABLE A.

Exposure of Northern Cattle to Southern Cattle Manure and Southern Cattle Ticks.

No. of Pen.	I.		III.			IV.	V
Pen. How Treated.	June 9, Manure, Little Rock June 9, Manure, Texarkana. Aug. 22, Manure, Ft. Smith.		June 24, Ticks, Baton Rouge, La. June 28, Ticks, Agricultural College, Miss. August 23, Ticks, Little Rock, Ark.				
No. of Animal.	11.	12.	31.	32.	33.	41.	51.
Entered Pen.	Aug. 2.	Aug. 7.	July 24.	Aug. 2.	Aug. 2.	Aug. 2.	July 31.
Sprinkled With Ticks.				Aug. 9. (Mississippi.)		Aug. 2. (Texarkana.)	Aug. 2. Aug. 3. Aug. 4.
	Record of Temperatures in Degrees Fahrenheit. (At 9 a. m.)						
1892, August 17	102.5	102.2	104.6	105.5	105.7	.....	
18	102	102	105	105	104.3	103.2	105.3
22	102	101.9	103	104.5	104.4	102.4	102
23	103	101.5	105.7	104.5	105	102.8	102
24	102.5	101.8	106.7	103.2	106.3	103	101.8
25	103.5	102	107.4	103	106.8	103	104.3
26	102.5	101.5	106.2	102.2	106.2	102	102.5
27	102.8	101	106	103	106.1	.....	102.
29	103.5	102.5	106.5	103.8	105	103.1	102.
30	102	101.8	105.6	102	103.8	102	101.
September, 1	101.8	101.5	103.2	102.1	.....	102	101
3	102.8	102.2	103.5	102	.....	102.4	101.
5	102.5	101.6	103	102.1	.....	.....	...
7	102.8	101.2	.....	101.8	.....	101.8	101.
9	103.2	102.5	.....	102.9	.....	102.1	102
12	102.5	101.4	.....	.....	.....	.....	...
14	103.8	102.8	.....	.....	.....	.....	...
16	103.4	102.9	.....	.....	.....	.....	...
19	102.4	101.8	.....	.....	.....	.....	...
22	104.5	.....	.....	.....	.....	.....	...
24	102.9	.....	.....	.....	.....	.....	...
26	102.8	.....	.....	.....	.....	.....	...

TABLE B.

Exposure of Northern Cattle to Southern Cattle Ticks of First and Second Generation.

No. of Pen.	III.					IV.	V.	II.	
Pen. How Treated	June 24. Ticks from Baton Rouge, La June 28. Ticks from Agricultural College, Miss. Aug. 23. Ticks from Little Rock, Ark							Sept. 1. Mature Ticks from calf 32 (Second gen. from Mississippi)	
No. of Animal.	34	35	36(41)	37	38(12)	42(32)	51	21	22
Entered Pen.	Sep. 5	Sep. 5	Sep. 7	Sep. 12	Sep. 14	Sep. 9	July 31	Sep. 22	Oct. 4
Sprinkled with Ticks.	Sep. 9 Sep. 13	Sep. 22	Sep. 13 Sep. 22	Sep. 22	Sep. 22	Sep. 22	Sep. 22	Sep. 29 Oct. 1	Oct. 4
	Record of Temperatures in Degrees, Fahr. (At 9 a. m.)								
1892, Sept. 5	102.6								
7	101.5	101.9	101.8						
9	101.8	102.7	102.1			102.9	102		
12	102	101.8	102.4	102 4		102.8	102.1		
14	102.6	102	102.5	102.5	102.8				
16	102	102	102.3	101.8	102.9	102.5	101.5		
19	101.5	101.8	102.1	101.8	101.8	102.2	102.1		
22	102	101.9	101.8	102	103	103.5	104.2	101.3	
24	102	104.5	102.7	101.5	103.2	102.6	101.8	101.5	
26	102.3	102.8	102.7	102.3	103.6	102.8	104	101.6	
28	102.5	102.1	103.3	103	103.8	103	102	101.8	
30	102	103.6	104.4	102.2	103.1	103.2	101.8	101.3	
Oct. 3	99.8	104.5	104.2	106.3	104.2	101.8	102	100.4	
5		103.6	106.2	106.8	105.7	101.4	101.8	101.2	101.7
7		106	105.6	105.5	106.5	103.2		101.8	102
8		104.2	104.5	102	105.2				
9		105.5	105.7	101.5	101.7				
10		104.5	103.8	101.8	99.7	101.5		107	102.3
11		103.6	103	101.8	100.9	101.3		107.5	105
12		103 2	102	101.3		102		106	105
(5:30 p.m.) 12			104.3	103.5				103.3	106.7
13		101.8	101.5	101.5		102.2			105.6
15		102.2	102	102.5		102			106.7
17		103.8	101.8	103.2		97.7			106
(5:30 p.m.) 17		104	103	103 9		101.8			106.6
19		102	102.7	103.6		102.3			105.5

Notes of Cases, Autopsies, Etc.

Table A, Case 31.—Old cow subjected to same test in previous year without showing disease. Temperature first taken, August 17th, at which time there was no sign of sickness, except elevated temperature. A few small ticks and one fully grown seen on body; dullness observed about the 21st, continuing for several days, but appetite continued fair. By September 1st apparently as lively as before. Killed September 24th.

Autopsy.—No ticks seen on skin; condition fair; mesentery dotted with patches of old blood extravasations from the size of a dime downwards; spleen slightly enlarged, (weight three pounds) not abnormally soft; liver shows on capsule many dark, slightly sunken patches, which, on section are seen to extend some distance into the substance of the organ. Under the microscope these seem to be broken down liver tissue infiltrated with extravasated red blood corpuscles. All the other organs appear normal. Result positive.

Case 32.—Bull calf, sixteen months old. Course of disease much like the last; appetite never lost; became enormously invaded by ticks. After temperature had returned to normal, it was subjected to the same test again. (See case 42, Table B.) Result positive.

Case 33.—This calf, fifteen months old, became invaded by ticks from the soil of pen only. Its temperature corresponded closely with that of 31, but otherwise it showed greater sickness, indicated by refusal of food, weakness, emaciation, etc. It was killed for examination, August 30th.

Autopsy.—Many ticks of various sizes on skin; flesh and subcutaneous fat normal; contents of thoracic cavity normal; fourth division of stomach contains some small gravel and sand, mucous membrane of same normal. On outer surface of intestines are visible several large patches of blood extravasation; spleen about one-half larger than normal, soft, but pulp not darkened as in acute cases; liver contains much blood and bile which flows from cut surface; gall-bladder half full of thick, ropy bile of dark yellow color; left kidney shows most marked abnormality, the fat and connective tissue surrounding it being infiltrated with blood to a

great extent, and the kidney itself discolored over part of its surface. Bladder contains a little amber colored urine; lymph nodes in lumbar region much darkened and engorged, in other parts they appear to be unchanged. Result positive.

Case 41.—Sprinkled with the young of a species of tick obtained on cattle at Texarkana, Ark. Only a few specimens of these were obtained, and adults were not preserved, as it was not noticed that they belonged to another species until mounts were made of the young. (Larvæ resemble those of *Ixodes albipictus.*) These young ticks only adhered to the calf a few days and then disappeared. Calf remained well. After five weeks it was sujected to further test in pen III. (See case 36.) Result negative.

Case 51.—This calf, two years old, raised a moderate number of ticks after being sprinkled. It never appeared sick, nor lost flesh nor appetite. The thermometric records leave the case doubtful. It was subjected to a second trial in the same pen without effect. (Ticks put on body were from Mississippi and Louisiana).

Autopsy.—October 6th, nothing abnormal was seen except traces of discoloration in the capsule of the kidney. Result uncertain.

Table B, Case 34.—Old cow, suckling calf, has a suppurating tumor at base of ear, very thin; case described earlier in report; no autopsy. Result considered negative.

Case 35.—Calf, three months old, suckling of 34, became invaded with ticks chiefly from soil, but also artificially; went through a non-fatal attack with great weakness, inappetence, languor, etc., with slow convalesence. No autopsy. Result positive.

Case 36.—(Same animal as described under 41, Table A.) This second test gave positive results. Course of disease similar to that of 35. No autopsy.

Case 37.—Eight months old bull calf; test and result same as in two previous cases. No autopsy. Result positive.

Case 38.—Eighteen months old bull calf. (No. 12, of Table A.) After being exposed one month in pen I. (to Southern cattle manure test) it was moved to pen III. and young ticks (Missis-

sippi) put on body. It was killed after having passed through a severe attack of fever with great weakness and loss of condition.

Autopsy, October 11th, reveals nearly the same appearances as in No. 33, but the liver was more enlarged and the bile almost tar-like in color and consistency; blood, small in amount, thin, and darker in color than normal, forms firm clot; much blood extravasation and effusion of yellow serous fluid around both kidneys and into their capsules; substance of kidneys and lining membrane of pelvis of same congested.

Case 42.—(Same animal as described under 32, Table A.) Second crop of ticks raised on body without occasioning any fever.

Autopsy, November 5th, revealed no pathological change except traces of old hemorrhage into the capsules of the kidneys. Result of second test, negative.

Case 21.—Four year old cow, subjected to test of second generation of young ticks, went through a typical case of acute Texas Fever; died October 13th, 8 a. m.

Autopsy, October 13th, 9 a. m. Large number of ticks on body, none exceeding in size a grain of rice. On removing the skin large patches of blood extravasation were seen on the left side of neck and over the right gluteal region; fat of subcuta of a deeper yellow than normal; superficial inguinal glands much enlarged and blood engorged; little blood, and that of a darker color than normal flows from cut vessels; bowels not opened, on outside appear normal; rectum empty, mucosa of same of a normal, pinkish red color; third division of stomach full of ingesta; fourth division contains a little fluid and its lining membrane is deeply congested; slight yellow peritoneal effusion. Spleen much enlarged, capsule dark slate color, pulp semi-fluid and dark. Liver greatly enlarged (weight 19 pounds) and engorged with blood and bile. Gall-bladder distended with dark, thick, granular bile. Kidneys enlarged and congested, capsule and pelvic lining membrane shows blood extravasations; connective tissue, fat, and peritoneum for a considerable distance around kidneys a mass of blood and serous effusion. Mesenteric lymph nodes congested. Bladder distended with dark colored urine. Left lung congested,

spongy; right less altered; pericardium and endocardium blood injected.

Case 22.—(Same animal described under 12, Table A.) After passing through test of cattle manure it was put into pen II., and ticks of second generation from the South put on body. It in due time suffered from a severe but non-fatal attack of Texas Fever. No autopsy.

Horticultural Experiments and Notes.

Notes on Station Vineyard at Fayetteville.—The Station vineyard is situated on a moderately steep hillside, with a southeast exposure. The soil is rather poor and rocky, and is inclined to be springy after rains. It was planted during the spring of 1888, and consists of one hundred and sixty-five of the leading varieties of grapes, most of which are living at the present time.

Judging from this year's crop, it would be safe to class one-half of the varieties as entirely unsuited to this climate and soil. But when the unsuitable location of the vineyard and its previous treatment are considered, it is probable that many of the varieties which should be reported as worthless under these conditions would be classed as good when grown on suitable soil and in a suitable location.

The vineyard was in a very unhealthy condition when work was commenced on it this spring. The vines made a poor growth last year, and they looked weak and sickly. The work this year has been what might be called "The Reviving of an Old Diseased Vineyard." This has been accomplished to a certain extent, but another year's treatment will be required to bring it to a healthy state. The soil was put in as good state of cultivation as the location would allow, and was kept free from weeds throughout the season.

The vines were sprayed five times during the season. In connection with the account of spraying, a weather table is given, showing the state of the weather during the spraying season. This table is interesting in this connection as the weather is an important factor in the development of black rot and mildew.

The vineyard was not sprayed during the season of 1891; the object being to ascertain what varieties would best resist black rot and mildew. As a result of the experiment a list of the varieties that best resisted the disease under those conditions was published in Bulletin No. 17. Most of the varieties named therein are contained in the list of those do-

ing the best this year. The amount of damage done by the black rot in the vineyard this season is estimated at ten per cent of the crop. With few exceptions the varieties named in the list as doing the best, were free from the rot and the mildew.

While the results obtained from spraying were not as good as might have been obtained had the vines been sprayed more often, still they are such as to convince that spraying is essential in the cultivation of the grape in this locality. The results would also have been better had the vineyard been sprayed last year. The varieties left unsprayed were a total loss of the crop from black rot. No fruit was gathered from them. The foliage was damaged to some extent by mildew.

Spraying the Vineyard.—The first spraying was given April 21st, with the Bordeaux mixture, Formula I. given subsequently. The vines, trellises and the ground surrounding were all wet with the mixture. The leaves had started and were one-third grown. The second spraying was made May 2nd, with Bordeaux mixture, Formula II. The wet weather at the time of this spraying and after, especially the few last days of May and the first days of June, was very favorable to the development of black rot and mildew.

Black rot made its appearance on a few grapes June 6th. Two days later there was a noticeable increase. At this time, June 8th, the third spraying was given, using Bordeaux mixture, Formula II. A period of dry weather followed. From one or both these causes the black rot was checked. At the time of the fourth spraying, June 27th, no increase of black rot was noticeable over that of June 8th. For this spraying Bordeaux mixture, Formula II. was again used. On July 12th the vineyard was sprayed with the ammoniacal solution of copper carbonate. The reason for using this solution was that it does not damage the appearance of the fruit, as does the Bordeaux mixture.

The photographs show an average comparison of sprayed and unsprayed vines.

UNSPRAYED VINE.

SPRAYED VINE.

WEATHER TABLE.

Date.	APRIL.				MAY.				JUNE.				JULY.			
	Precipitation.	Maximum Temperature.	Minimum Temperature.		Precipitation.	Maximum Temperature.	Minimum Temperature.		Precipitation.	Maximum Temperature.	Minimum Temperature.		Precipitation.	Maximum Temperature.	Minimum Temperature.	
1	.51	72	45	fair	.....	82	62	fair	1 47	63	51	cloudy	.....	84	59	clear
2	.....	79	40	clear	.....	75	64	cloudy	.10	71	49	clear	.....	84	70	cloudy
3	.85	78	64	cloudy	.96	85	56	cloudy	.....	75	46	fair	.74	81	65	cloudy
4	.51	76	62	fair	... ..	83	63	fair	.....	79	56	clear	.....	78	52	cloudy
5	.....	71	42	clear	.....	84	66	cloudy	.30	72	60	cloudy	.....	78	54	fair
6	.....	67	43	cloudy	T.	89	62	cloudy	.21	82	60	fair	.....	79	57	fair
7	.....	74	48	clear	.01	69	59	cloudy	.....	86	60	fair	.....	78	61	cloudy
8	T.	54	42	fair	.89	70	54	cloudy	.....	85	65	clear	.10	77	64	fair
9	.....	53	30	clear	.41	70	51	cloudy	.....	87	65	clear	.....	80	60	fair
10	.....	58	38	cloudy	.....	60	42	fair	.....	90	62	clear	.11	81	61	cloudy
11	.....	62	41	cloudy	.....	66	42	clear	.....	90	61	clear	.. ..	88	62	clear
12	.05	61	43	cloudy	.....	78	50	cloudy	T.	90	66	clear	.39	89	67	cloudy
13	.....	73	46	fair	.51	76	60	cloudy	.....	91	71	clear	.....	80	67	fair
14	.....	52	34	cloudy	2.85	76	57	cloudy	.....	90	67	clear	.....	89	70	fair
15	.....	67	33	clear	.95	71	58	cloudy	.....	92	66	clear	.. ....	92½	71	clear
16	.....	77	53	fair	.....	79	58	cloudy	.....	90	68	clear	.51	91	68	cloudy
17	.....	86	62	fair	1.50	70	56	cloudy	1.30	91	67	fair	.....	86	67	cloudy
18	.....	90	66	cloudy	.15	69	55	fair	.....	83	65	fair	.....	88	70	clear
19	1.55	82	58	fair	.51	64	47	cloudy	.....	88	64	fair	.....	92	72	cloudy
20	.85	73	55	fair	.15	64	45	cloudy	.....	90	66	clear	.....	93½	70	clear
21	.....	64	46	fair	.17	49	38	fair	.....	89	67	clear	.....	94	72	clear
22	.....	59	38	clear	.....	63	37	clear	.....	89	69	clear	...	94	70	clear
23	.....	65	37	fair	.....	70	42	clear	.....	85	69	cloudy	.....	92	68	clear
24	.17	67	48	fair	.....	49	47	clear	.17	84	69	cloudy	.....	92	70	clear
25	.....	77	48	fair	.17	74	59	cloudy	.....	85	66	fair	.....	92	68	fair
26	.....	81	59	fair	.....	80	58	fair	.....	91	65	fair	T.	93	67	fair
27	.....	83	65	cloudy	.27	72	58	fair	.....	79	64	clear	.....	90	70	clear
28	.27	71	45	cloudy	.10	82	60	fair	.....	85	52	clear	.....	91	71	cloudy
29	.....	93	42	clear	1.00	85	57	fair	.....	91	58	fair	.21	84	67	fair
30	.....	80	55	clear	1.42	84	58	cloudy	1.80	78	61	fair	.....	89	65	cloudy
31	.....	....	....	.....	.....	78	60	cloudy	.....	....	....	.....	.05	87	66	fair

NOTE.—This table is taken from the weather record kept at this Station by Prof. G. L. Te

Notes on Grapes Doing Best in the Station Vineyard this Season.

Norton's Virginica.—Vine, strong grower and healthy. Bunch, resembling Cynthiana very closely. Berry, same size as Cynthiana and very similar. Yield, very good.

Herbemont.—Vine, good grower. Bunch, large, long and shouldered; compact. Berry, small, black; skin thin; flesh very sweet; no pulp. Damaged some by black rot. Yield, medium to good.

Lindley.—Vine, good; healthy grower. Bunch, medium, long, not compact. Berry, large, red. Flesh, tender, juicy; very little pulp; quality, very good. Yield, good.

Concord.—Vine, vigorous and healthy; strong grower. Bunch, large, shouldered, not compactly filled. Berry, large, black with blue bloom; skin thin; flesh sweet, pulpy. Some damage from black rot. Yield, medium.

Woodruff Red.—Vine, good growth. Bunch, large, shouldered and moderately compact. Berry, large, fine looking red grape. Yield, good.

Perkins.—Vine, good strong grower. Bunch, medium to large, shouldered. Berries, medium; color, red with white bloom; flesh pulpy, sweet and juicy. Yield, medium to good.

Cottage.—Vine, medium grower but healthy; good growth this year. Bunch, large, shouldered, moderately compact. Berry, medium to large; color black; skin thin; flesh tender, juicy. Yield, good.

Agawam.—Vine, very vigorous and healthy. Bunch, medium to large, compact. Berry, fine, large, red. Yield, very good.

Cynthiana.—Vine, fine, healthy grower. Bunch, large, shouldered, compactly filled. Berry, small to medium; black with a blue bloom; flesh sweet and moderately juicy. Yield, very good.

Wyoming Red.—Vine, vigorous, healthy grower. Bunch, small and compact. Berry, medium; color red; skin thin; flesh sweet and of good flavor. Yield, good.

Delaware.—Vine, medium grower. Bunch, small to medium, compact. Berry small to medium; skin thin; flesh sweet, tender and juicy; color red; quality good. Yield, medium.

Lady Washington.—Vine, medium grower. Bunch, large, shouldered. Berry, medium; somewhat yellowish in color, with white bloom; flesh tender, juicy and sweet; flavor very good. Yield, medium.

Worden.—Vine, medium grower, but healthy. Bunch, large and shouldered. Berry, large, black; flesh sweet. This grape resembles Concord but ripens earlier and produces better. Yield good.

Niagara.—Vine, vigorous and healthy. Bunch, medium to large, somewhat shouldered. Berry large; skin thin; color pale green at first but pale yellow when ripe, with a white bloom; flesh sweet, tender and pleasant to the taste. Yield, medium.

Ives Seedling.—Vine, vigorous grower. Bunch, medium, shouldered and compact. Berry, medium, black when ripe; flesh sweet and juicy; flavor not the best. Yield, medium to good.

Notes on Location, Planting and Care of a Vineyard.

A high and well drained situation is best for grapes. A southern slope is preferred, as the vine needs all the warmth possible. A steep hillside is not suitable, as the expense of keeping it in a good state of cultivation makes the location impracticable. Shelter is quite an item in the location of a vineyard. A wind-break on the north is an advantage. Where a natural wind-break cannot be obtained an artificial one may be made by planting some variety of evergreen.

Soil.—The best soil is a dry, calcareous loam. Moderately rich, sandy soil is preferable to clay. Heavy, soggy, clay soils are to be avoided unless thoroughly drained. Before planting, the soil should be well stirred to the depth of sixteen to twenty inches. This can be done with a common stirring plow followed by a subsoil plow. The thorough preparation of the soil is very important.

Andrew S. Fuller says in the *Grape Culturist*: "We should always endeavor to make thorough work in the preparation of the soil before planting the vines, for it is not an ordinary crop that we are to plant, nor one that necessitates a seed time to each harvest, but it is one that requires but one planting in a lifetime, yet it will reward us with many harvests."

Planting.—Extra strong one year old or two year old vines are the best for planting—never older than two years. Planting should be done in the fall, after the vine is in a dormant state, or early in the spring before the buds start. Fall planting is preferred where it can be done, as the roots become calloused and the soil well settled about them, thus giving the conditions for early growth in the spring. At time of planting, the roots should be cut back if they are extra long. If short, the ends should all be trimmed off. The roots should not be allowed to become dry during the process of transplanting.

Pruning may be done at any time during the winter, while the plant is in a dormant state. Mild weather should be selected so as not to prune while the vine is frozen. After the pruning has been completed, all trash should be removed from the vineyard and burned and the ground raked clean. This is important where black rot attacks the grapes, as the spores of the fungus live over winter in the diseased fruit of the previous year. Pruning should be thoroughly understood before undertaking it.

Cultivation.—The soil should be frequently stirred (though never deep) to prevent noxious vegetation, especially during the growing season. When the growing season is about over, one or two rows of field peas should be planted between the rows of grapes to protect the soil and grape roots from the hot sun of July and August. The pea vines shade the soil, keeping it cool, loose and moist, and will yield a good quantity of peas, which will more than pay expense of planting The vines enrich the soil very much, and should remain on the soil, and when decayed in the spring turn in shallow with some kind of fertilizer or compost. The fertilizing is very important, and is demanded for an annual yield of good grapes. The peas planted in the Station vineyard and young orchard grew heavy vines and yielded a large crop of peas.

The Treatment at the Station of Two Common Fungous Diseases of the Grape.

Downy Mildew.—Downy mildew is first noticed as small whitish spots on the under side of the leaf. These spots increase in size and soon unite, forming larger ones—sometimes nearly covering the entire leaf. On the upper surface are light brown spots which gradually become larger and darker in color, and the leaf finally dries up and falls off.

The mildew attacks the leaves, the young shoots and the berries. The berries are attacked while quite small, usually when about the size of small peas. They turn brown or gray in color (this is also called brown rot). The bark of the affected shoots show shriveled or shrunken spots or patches. The mildew thrives under the same climatic influences as the black rot; however, it usually makes its appearance before the black rot.

The mildew deprives the vine of its leaves at the time they are needed to aid in the proper ripening of the fruit. It

also damages the young shoots, leaving them in an unhealthy condition.

Black Rot.—The first appearance of black rot is noticed on the leaves as spots of a reddish brown color. On the surface of these spots are black points, or pustules, which may be seen with a magnifying glass. The rot makes its appearance on the fruit when the berries are about two-thirds grown. It is here first noticed as a small brown spot, which gradually enlarges until the whole berry is covered, then the color is almost black. The surface is covered with the black points or pustules, which is a characteristic of the black rot. The berry finally becomes withered and dried up, but usually remains on the stem. Warm and wet weather are necessary for the rapid development of the black rot.

Spraying for Mildew and Black Rot.—Spraying for these diseases is purely a preventive remedy. The spores live through the winter in the diseased berries of the previous year and the leaves and the rough bark of the canes.

The first spraying should be given early in the spring, before the buds begin to open. For this spraying the simple solution of copper-sulphate is used, as it is cheaper and as easily prepared and answers the purpose as well for this spraying as the other fungicides. This solution should not be applied after the leaves open, as it is liable to damage them.

The second spraying is given when the leaves are about one-third grown. The third is given after the leaves are fully grown, and the fourth in about twenty days after. The fifth and sixth sprayings should follow in periods of about twenty days. Sometimes the sixth spraying is not necessary.

For the second, third and fourth sprayings, the Bordeaux mixture is used, and for the fifth and sixth use the ammoniacal solution of copper-carbonate, as this solution does

not damage the appearance of the fruit, and is fully as effective as the Bordeaux mixture. Should the Bordeaux mixture be used for the last sprayings, the stains on the fruit may be removed by dipping the bunches in weakened vinegar.

When a rain immediately follows a spraying, it should be repeated; but when using the Bordeaux mixture, a few hours' drying will prevent its removal by a moderate rain.

Fungicides and Insecticides.

The reports received show that spraying, to prevent plant diseases and for insects, is carried on in only a few localities in the State. Seven counties report that spraying is done to a greater or less extent. Nearly all report damage from fungous diseases and insects, and many of the correspondents mention that spraying is needed, and ask for information as to best remedies and means of applying them. The following is given in compliance therewith:

The most common fungicide is Bordeaux mixture. It has been used for years, and has given very satisfactory results. The formula for the mixture, as generally recommended, is given below as Formula III. Formulas I and II have given as good results and are cheaper. Formula II is recommended for orchard spraying.

Formula I.

Sulphate of Copper (Blue-stone)	6 pounds
Lime	4 pounds
Water	32 gallons

Formula II.

Sulphate of Copper	6 pounds
Lime	4 pounds
Water	45 gallons

Formula III.

Sulphate of Copper ..... 6 pounds
Lime ..... 4 pounds
Water ..... 22 gallons

How to Prepare for Use.—Dissolve the copper-sulphate in four gallons of hot water. In another vessel slake the lime in four gallons of cold water. When cool, the milk of lime should be slowly poured into the copper solution. Care should be taken that no large particles get into the mixture. To prevent this, the milk of lime should be strained through a seive or gunny-sack. Enough water is now added to make the mixture of the required strength.

Ammoniacal Solution of Copper-Carbonate.—This solution is used in place of the Bordeaux mixture to some extent. The reasons for so doing are that it is easier to apply; it does not stain the fruit, and it is as effectual.

Formula:

Carbonate of Copper ..... 5 ounces
Aqua Ammonia (26°) ..... 3 pints
Water ..... 40 gallons

Dissolve the copper carbonate in the ammonia, add to forty gallons of water, and the solution is ready for use.

NOTE.—When spraying with Paris green or London purple for codling moth or plum curculio, in combination with fungicides, always use Bordeaux mixture in place of ammoniacal solution, as the arsenites, when used in connection with the latter, will injure the foliage.

Simple Solution of Copper-Sulphate.—

Formula:

Copper-Sulphate (sulphate of copper) ..... 1 pound
Water ..... 25 gallons

Dissolve one pound of sulphate of copper in one gallon

of hot water, add twenty-four gallons of water, and the mixture is ready for use.

Insecticides.—The two leading insecticides are London purple and Paris green. The value of both depends upon the arsenic which they contain. The former is a refuse product from dye works, and is of a purple color. The latter is an arsenite of copper, and is of a bright, green color. Both are practically insoluble in pure water, and for this reason are preferable to white arsenic, which has sometimes been recommended for spraying purposes. Aside from its injury to foliage, because of this slight solubility, white arsenic is less readily distinguishable from other substances, and is more dangerous to have about the farm.

To prepare for use, enough water is added to the poison to make a thin paste. This can be stirred into a vessel containing the required amount of water.

The formula recommended is one pound London purple or Paris green to two hundred gallons of water. If used much stronger than this the foliage is liable to injury, but the poison may be used much stronger when freshly slaked lime is added. Stronger than one pound to one hundred and sixty gallons of water would not be recommended, as that strength is effectual.

The opinion of a practical fruit grower of Arkansas as to the value of spraying is given in the following extract from a letter received from Mr. G. L. Coleman, of Ft. Smith, under date of September 5, 1892. "Last year I sprayed my grapes for the first time, and saved my crop. This season I sprayed again and have a good crop, although the season has been very wet and bad for grapes. I sprayed my plums this season and had a good crop. Also, I sprayed my apple and peach trees. My peach trees were filled with fine peaches, although my neighbors' orchards were a failure. I think spraying is a great benefit, and I shall spray all my fruits next season."

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Spraying Pumps for Applying Insecticides and Fungicides.

Several firms are making a specialty of the manufacture of spraying pumps. When purchasing these pumps, it is best to write to several manufacturers for catalogues and price lists: Field Force Pump Co., Lockport, N. Y.; Nixon Force Pump and Nozzle Co., Dayton, Ohio; William Stahl, Quincy, Ill.; Gould Manufacturing Co., Seneca Falls, N. Y.; Albinson & Co., No. 2026 Fourteenth street, N. W., Washington, D. C.; The Deming Co., Salem, Ohio.

For spraying grapes and all plants not over ten feet in height, the knapsack sprayer is best, as the operator carries it on his back and has complete control of the spray, thus enabling him to reach all parts of the plant, as is essential in spraying with fungicides. These pumps hold about five gallons. (When spraying large areas, it is not practical to use them). When spraying twenty acres or more it would be advisable to use a barrel spray pump or a tank pump.

For orchard spraying a barrel spray pump may be used for small areas, but for large areas a tank machine with gearing to run the pump is the most practical.

Nozzles.—The companies manufacturing spraying pumps also manufacture nozzles. The value of the nozzle depends: 1st, Upon the fineness of the spray, especially when spraying with fungicides. 2nd, The nozzle must be so constructed that it will not readily clog, and if it does, that the obstruction can be easily removed.

Several of the best nozzles were tested on the grounds this season. The Vermorel nozzle gave the best results. It throws a fine mist-like spray and is not liable to clog.

When spraying trees with this nozzle a long hose should be used, with a light pole attached, to enable the operator to

reach all parts of the tree, or what is better, a bamboo extension. By so doing, large trees can be effectively sprayed with this nozzle. The Vermorel nozzle is manufactured by all the companies, and sells for a small sum.

Reports from Counties on Apples and Grapes.

To collect data for this department, on fruit growing in this State, a circular letter containing a list of questions on apples, grapes, peaches and plums, was sent during the past summer, to parties in most of the counties of the State interested in fruit growing. Two letters were sent to each county. The questions on apples were:

Name varieties doing best in your county?

What injurious insects attacking the apple?

Any apple scab?

Those on grapes were:

Name varieties most successfully grown in your county.

Are you troubled with grapes rotting on the vines?

Any injurious insects attacking grape?

The answers to the questions are given in the following tables. The majority of letters were very complete, and contained much additional information concerning the fruit interests of the State, and are here subjoined, in substance, to furnish a general idea of the apple and grape industry in this State:

APPLES.

COUNTY.	VARIETIES.	Diseases.	Insects.
Ashley	Early Harvest, Maiden's Blush, Ben Davis, Horse, Shockley	Apple Scab.	Borer.
Benton	Early Harvest, Winesap, Ben Davis, Maiden's Blush, Red June, Limbertwig, Mammoth, Pippin, Smith's Cider	Apple Scab. Black or Bitter Rot.	Codling Moth. Tent Caterpillar.
Boone	Early Harvest, Red June, Rambo, Red Astrachan, Maiden's Blush, Golden Pippin, Golden Russett, Winesap, Blacktwig, Rome Beauty, Shockley, Ben Davis		Codling Moth.
Bradley	Red and Yellow June, Horse, Ben Davis, Golden Russett, Pippin	Apple Scab. Bitter Rot.	Borer.
Carroll	Ben Davis, Rome Beauty, Winesap, Limbertwig, Arkansas Black, Fall Queen		Codling Moth. Borer.
Clay	Winesap, Ben Davis, Winter Pearmain, Rambo, Stark's Keeper		Codling Moth.
Columbia	Yellow May, Red May, Red June, Red Astrachan, Early Harvest, Horse, Fall Pippin, Ben Davis, Arkansas Black	Apple Scab.	Codling Moth.
Craighead	Red June, Ben Davis, Shockley.	Apple Scab.	Codling Moth.
Crawford	Early Harvest, Red Astrachan, Ben Davis, Shockley, Red June, Shannon, Winesap	Some Apple Scab	Codling Moth.
Cross	Winesap, Ben Davis, Shockley, Russett	Apple Scab.	Borer.
Desha	Ben Davis, Winesap, Horse, Pippin, Shockley, Taunton, Kentucky Streak	Apple Scab. Twig Blight.	Borer.
Drew	Red Astrachan, Julian, Taunton, Carter's Blue, Shannon, Buckingham, Yates, Horse, Red June, Golden Russett	Leaf and Twig Blight.	Codling Moth. Borer. Caterpillar.
Faulkner	Ben Davis, Red and Yellow June	Apple Scab.	
Franklin	Winesap, Ben Davis, Shockley, Arkansas Black		Codling Moth.

APPLES—Continued.

COUNTY.	VARIETIES.	Diseases.	Insects.
Garland	Shannon, Ben Davis, Early Harvest, Willowtwig, Grimes' Golden	Apple Scab.	
Greene	Winesap, Horse, Limbertwig, Red Astrachan, Rome Beauty, Shockley, Red Winter Sweet, Tallman Sweet, Early Harvest, Maiden's Blush, Duchess of Oldenburgh	Apple Scab.	Codling Moth. Tent Caterpillar.
Izard	Winesap, Ben Davis, Limbertwig, Rome Beauty, Rambo, Turner Green, Red June, Early Harvest, Kentucky Red.	Apple Scab.	Codling Moth. Borer.
Johnson	Ben Davis, Willowtwig, Little Romanite, Johnathan, Red Russette, Limbertwig	Apple Scab.	Borer.
Little River	Red Astrachan, Red June, Shockley, Sweet June, Summer Red, Yellow Horse, Hall's Seedling, Bell's Winter, Shannon, Arkansas Black.		
Logan	Early Harvest, Red Astrachan, Horse, Duchess of Oldenburgh, Buckingham, Maiden's Blush, Ben Davis, Golden Pippin, Shockley, Winesap, Arkansas Black, Rambo, Red June, Summer Queen, Yellow Bellflower, Westfield, Winter Pearmain	Apple Scab.	Codling Moth. Borer. Caterpillar.
Lonoke	Red June, Ben Davis, Winesap, Shockley	Apple Scab.	
Madison	Ben Davis, Winesap, Red Limbertwig, Maiden's Blush, Arkansas Red. Early Harvest, Shannon Pippin.	Apple Scab.	
Marion	Early Harvest, Summer Queen, Buckingham, Ben Davis, Willowtwig, Winesap, Winter Pearmain	Apple Scab.	
Miller	Early Harvest, Shockley, Shannon, Red Astrachan, Ben Davis		

APPLES—Continued.

COUNTY.	VARIETIES.	Diseases.	Insects.
Mississippi	Early Harvest, Red Astrachan, Carolina or Red June, William's Favorite, Maiden's Blush, Shannon, Gravenstein, Tetofsky, Utter's Red, Haas.	Apple Scab. Black Rot or Bitter Rot.	Codling Moth.
Newton	Red Russett, Winesap, Pewaukee, Ben Davis, Shockley, Shannon Pippin, Johnathan, Willowtwig, Romanite	Apple Scab.	Codling Moth.
Ouachita	Early Harvest, Red Astrachan, Red June, Horse, Carter's Blue, Ben Davis, Winesap, Shockley, Red Limbertwig	Twig Blight.	Borer. Aphis. Codling Moth.
Perry	Early Harvest, Red June, Summer Red	Apple Scab.	
Phillips	Ben Davis, Shockley		Codling Moth.
Poinsett	Ben Davis, Nickajack, Winesap, Nashville Mammoth	Apple Scab.	
Polk	Arkansas Black, Winesap, Kentucky Red, Shockley, Shannon, Nickajack, Rome Beauty, King of Thompkins' Co.		
Pope	Red June, Shockley	Twig Blight.	
St. Francis	Ben Davis, Leather Coat, Kentucky Streak	Apple Scab.	Borer.
Scott	Kentucky Red, Blacktwig, Limbertwig, Ben Davis, Winesap, Shannon	Apple Scab.	
Sebastian	Red June, Red Astrachan, Early Harvest, Yellow Transparent, Tuscaloosa Seedling, Webb's Winter, Shockley, Colvert	Apple Scab.	
Sharp	Kentucky Red, Ben Davis	Apple Scab.	
Stone	Stone County Favorite, Winesap, Early Harvest, Bellflower, Red June	Apple Scab. Apple Rot.	
Union	Horse, Red June, Early Harvest, Shockley, Yates, Shannon	Twig Blight.	Borer.

APPLES—Concluded.

COUNTY.	VARIETIES.	Diseases.	Insects.
Van Buren	Ben Davis, Winesap, Missouri Pippin, Red June, Summer Pearmain, Early Harvest, Red Astrachan, Rusty Coat, Maiden's Blush, Golden Pippin		Borer. Codling Moth. Aphis.
White	Red June, Yellow June, Winesap, Johnathan, Horse, Tauntan, Shockley, Early Harvest, Red Astrahan, Sops of Wine, Arkansas Black	Black or Bitter Rot	Codling Moth. Borer.
Woodruff	Red June, Winesap, Horse, Bellflower		
Yell	Red June, Early Harvest, Ben Davis, Shannon Pippin, Winesap	Apple Scab.	

NOTE.—In the tables the names of varieties are given as they occur in the reports of the correspondents. Though some varieties are for different localities given under different names, no attempt is made to indicate such, as it cannot be accurately done without a full description of the fruit.

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GRAPES.

COUNTY.	VARIETIES.	Diseases.	Remarks.
Ashley	Concord, Rogers, Isabella, Scuppernong	Black Rot	
Benton	Concord, Ives' Seedling, Moore's Early	Black Rot	Leaf Roller. Curculio.
Boone	Concord, Martha, Delaware, Gœthe, Hartford, Dracut Amber, Ives' Seedling, Perkins.		Curculio
Bradley	Ives' Seedling, Scuppernong, Martha Washington	Black Rot	
Carroll	Concord	Black Rot	Curculio.
Clay	Concord	Rot	
Columbia	Concord, Ives' Seedling	Rot	
Crawford	Concord, Delaware, Perkins, Norton's Virginica, Cynthiana, Ives' Seedling, Moore's Early	Black Rot	Grapes injured by insect puncture.
Cross	Concord		
Desha	Ives' Seedling, Scuppernong	Rot	
Drew	Ives' Seedling, Delaware, Norton's Virginica, Cynthiana, Scuppernong, Thomas, Flowers, Perkins	Some Grape Rot	
Franklin	Ives' Seedling, Norton's Virginica	Grape Rot	Curculio.
Garland	Ives' Seedling, Concord, Martha, Cynthiana	Black Rot	Ives' Seedling surest crop.
Greene	Concord, Champion, Ives' Seedling, Brighton, Moore's Early, Pocklington, Noah	Black Rot	Noah does not rot.
Izard	Concord, Martha	Black Rot	
Jackson	Telegraph, Moore's Early, Concord, Delaware, Niagara, Cottage, Lady Washington, Early Victor	Grape Rot to some extent	
Little River	Ives' Seedling, Concord, Delaware, Martha, Scuppernong	Rot	Concord rots badly in wet season.

GRAPES—Concluded.

COUNTY.	VARIETIES.	Diseases.	Remarks.
Logan	Hartford, Ives' Seedling, Martha, Dracut Amber, Cynthiana.	Grape Rot.	Insects puncture the fruit.
Lonoke	Concord, Ives' Seedling, Delaware		Leaf Folder.
Madison	Concord, Worden, Ives' Seedling	Grape Rot.	
Marion	Concord, Martha		Grapes do not rot if pruned heavily in summer.
Miller	Cynthiana, Niagara, Ives' Seedling, Concord, Martha, Delaware, Scuppernong, Norton's Virginica		
Ouachita	Concord, Martha, Ives' Seedling, Scuppernong, Delaware, Worden, Norton's Virginica.	Grape Rot.	Almost entire crop rots some years.
Perry	Martha, Ives' Seedling, Delaware	Rot Some Seasons	
Phillips	Delaware, Concord	Rot	
Polk	Concord, Hartford	Grape Rot.	
Pope	Concord	Grape Rot.	
Prairie	Concord, Ives' Seedling	Grape Rot.	Leaf Roller.
St. Francis	Iron Clad, Moyer	Grape Rot.	
Scott	Ives' Seedling, Norton's Virginica, Cynthiana	Grape Rot.	The Concord, Isabella, Niagara, and several varieties of white grapes rot unless sprayed, if sprayed they do well.
Sebastian	Concord, Clinton, Elvira Martha, Delaware, Hartford, Ives Seedling, Norton's Virginica.	Grape Rot.	Insects puncture the fruit.
Sharp	Concord	Black Rot.	
Van Buren	Concord, Catawba, Diana, Isabella	Black Rot.	Leaf Roller, Curculio.
White	Ives' Seedling, Moore's Early, Concord	Rot	Leaf Roller. Ives nearly free from rot.
Yell	Concord, Ives' Seedling, Scuppernong	Black Rot.	

A specimen of reports from which the foregoing tables are prepared, is given below. Some of the reports, however, were not so complete as others:

REPORT FROM MISSISSIPPI COUNTY.

Apples.—Most of the summer and fall apples do well here, notably the following: Early Harvest, Carolina June, Red Astrachan, Williams Favorite, Tetofsky, Gravenstein, Haas, Maiden's Blush, Utter's Red and Shannon. Nearly all the winter apples ripen too early, making them inferior in quality, appearance and size, and rendering them poor keepers.

The codling moth is quite injurions in some localities, and I have noticed some apple scab; and late varieties are badly subject to black rot and dropping before maturity.

No fruit is grown in this county for shipping, on account of want of railroad transportation.

Pears.—The pear is, par excellence, the fruit of this country. Both trees and fruit seem to be free from disease. Trees are thrifty, bear abundantly and regularly, and the fruit is large, handsome and of good quality. I raise on my place, without any extra care, fruit of the following that can not be surpassed in any market: Duchess, Bartlett, Clapp's Favorite, Lawrence, Louise Bonne, Flemish Beauty, Doyenne d'Ete, on both standard and half standard stocks; and the Kieffers and Lecontes are extraordinary. The latter are scarcely fit to eat out of hand, but make excellent preserves and baking fruit.

Plums.—The native plums, especially the Wild Goose, do well. They bear large and regular crops of fine fruit, and are subject to few diseases or insects. The curculio is about the only enemy to it, and this not to a very great extent. I have found none of the European varieties that will suc-

ceed. I am experimenting with some of the Japan varieties, to-wit: Kelsy, Botan, Ogon and Satsuma. Last year one Kelsy tree bore about a bushel of large, beautiful fruit, ripening to maturity without any accidents. This spring my entire plant was white with bloom, when that late cold spell, in the latter part of March, struck it. All the fruit was killed, but the trees were not hurt. I am satisfied with the hardiness of the trees in this climate, but, as they bloom so early, I am afraid the fruit is going to be killed too often for them to succeed.

Peaches.—As a crop, the peach does no good here. The cold catches it one year out of three; and it is so subject to the ravages of the curculio, and a disease which causes it to rot just as it begins to ripen, that we do not get an average crop once in five years.

Grapes.—I have tried many of the hardiest varieties, and found none that would pay as a crop. The vines grow luxuriantly, and seem exempt from disease, but the fruit rarely ever matures in perfection; a few berries, only, ripening on a bunch at a time, and these spoiling before others ripen.

Small Fruits.—The strawberry grows here to perfection. I have raised it for five years, without failing to make an average crop. Last year and this, I gathered, from one-quarter of an acre of ground, 1,500 quarts of berries each year, that sold in our little town for an average of fifteen cents per quart, when berries brought from Memphis sold at the rate of two quarts for fifteen cents. I cultivate the Cumberland, Charles Downing, Bubach and Warfield; growing them in matted rows, with good culture between, and renew every three years.

The Turner and Cuthbert raspberries do well; the black caps seem to sun scald, in the winter time, and are unreliable.

Spraying.—No efforts have been made to combat insect attacks and plant diseases. I have been studying up the matter with the view of making experiments this coming year with the arsenites, Bordeaux mixture, and kerosene emulsion upon the apple, plum, peach and grape for curculio, codling moth, rot and dropping, and will be pleased to advise you of the results. S. S. SEMMES.

Apple Scab, Codling Moth and Plum Curculio.

Many requests are received for information and treatment for apple scab, codling moth and plum curculio—especially concerning the apple scab—and by a glance at the reports on apples in the foregoing table, its general prevalence is perceived. In the same table may also be seen the prevalence of the codling moth. In view of the requests and reports on these specially injurious agencies to apples and plums, a brief report of the best means now known to combat them is herewith appended:

Apple Scab.—This disease is very destructive; it lessens the yield and injures the sale of apples, and some years certain varieties are so damaged as to be unmarketable.

Prof. W. C. Sturgis describes apple scab as follows: *"This disease attacks the leaves and fruit of the apple, producing roundish or irregular blotches on the upper surface of the leaves and on the fruit. These blotches are of a dark greenish brown color, and of a more or less velvety texture. The growth of a fungous causing these blotches does not tend to produce any rapid or widespred decay in the fruit, but it does stunt and distort the fruit, rendering it to a greater or less degree unsightly and unmarketable. The "scab" should not be confounded with the diseases known as bitter rot and black rot, both of which tend to produce rotten areas in the fruit."

*Bulletin No. 111, Connecticut Agricultural Experiment Station.

Spraying for Apple Scab.—Spraying for this disease should begin early, as the spores live through the winter in the dead leaves and crevices of the bark of the tree. The first should be made with the simple solution of copper-sulphate before the buds open. The second immediately after the blossoms fall, and the third in about twelve or fifteen days. If necessary, a fourth spraying may be made in about twenty days from the third.

For each spraying, except the first, use Bordeaux mixture, Formula III. The ammoniacal solution of copper-carbonate is as effective and more easily applied than the Bordeaux mixture, but it cannot be applied with the arsenites, (London purple or Paris green), as the foliage is damaged by them when in combination with this solution, owing to the greater solubility of the arsenic when ammonia is present. If the arsenites are not used in combination with the fungicide, the ammoniacal solution is preferable.

The treatment for apple scab is such as to diminish the effects of the other fungous diseases of the apple—such as the "rust," "bitter rot" and others.

The spraying for the bitter rot or ripe rot should be done after the apples are nearly grown, as they are not attacked until nearly or quite ripe. The ammoniacal solution of copper-carbonate should be used when spraying for this disease. If the trees have been sprayed for the apple scab during the season, two sprayings will suffice for the bitter rot, and should be given about fifteen days apart.

Dr. B. D. Halsted says:* "Let it be remembered that when a fungicide is applied, it is, as a rule, helpful for all diseases. Thus, should a plum tree be sprayed for fruit rot, it will tend to check the leaf fungi that may be present. In like manner spraying the apple for the scab will probably diminish the mildew, the rust and the various leaf blights that

*Bulletin No. 86, New Jersey Agricultural Experiment Station.

are likely to be at work. Therefore, a treatment for one enemy may do much combined good against the others."

Apple Worm or Codling Moth.—The moth of this familiar worm appears at about the time the apple blossoms open. The female deposits the egg upon the apple as soon as the blossoms fall. It hatches in about a week or ten days, and the larva begins to eat toward the core of the apple. It continues feeding in the neighborhood of the core for three or four weeks, and then eats its way out through the side of the apple and leaves it. It then goes through the different stages common to such insects, and appears as a moth in about a month, when the eggs are laid for the second brood.

Spraying for the Codling Moth.—Spraying with the arsenites is now recognized as the best remedy for this pest. The first spraying should be made soon after the blossoms fall. If made before, it will be destructive to bees which visit the open blossoms, and if delayed till long after, at least a portion of the larvæ will have gained entrance to the apple, where they will be out of reach of the arsenic. The importance of not spraying before the blossoms fall cannot be too strongly urged. It is indirectly injurious to the fruit growers themselves by destroying the insects so important to the thorough fertilizing of the flowers, and does not prove more destructive to the codling moth. Furthermore, it is highly injurious to bee-keepers in the vicinity by destroying not only the visiting insects, but the young bees in the hive as well. The second spraying should be made in about ten days after the first.

Plum Curculio.—This well-known beetle makes its appearance early in spring, and feeds on the leaves and fruit during the entire egg-laying period, which frequently lasts for several weeks. The eggs are laid within crescent-shaped punctures made by the female on the fruit. In a few days the egg hatches, and the grub feeds upon the interior of the fruit, finally causing it to fall to the ground.

The remedy for this insect consists in destroying the beetle. Spraying with the arsenites has been tried for some years with some degree of success, but it has not proved as effectual as have the same remedies for the codling moth. The first spraying should be given immediately after the blossoms fall, and the second and third sprayings should follow in periods of about eight days each.

The beetle is easily jarred from the trees, and will generally remain motionless for some minutes. This fact is taken advantage of to collect them upon sheets placed under the tree. The sheet should be large enough to catch all that falls. It may be tacked to a light frame, which will make it convenient to carry from tree to tree. The beetles should be collected and crushed or put into a vessel containing kerosene. The jarring is done by striking with a heavy mallet, which should be padded to prevent injury to the tree. The time should be late in the evening or very early in the morning. This is a sure method of getting rid of the insect, if the work is vigorously kept up. The trees should be jarred every day, and the work should be continued as long as any insects can be caught.

ACKNOWLEDGMENT.

The Horticultural department acknowledges thanks for the excellent reports made to the department by the following correspondents.

NAME.	POSTOFFICE.	COUNTY.
Thomas Baker	Fountain Hill	Ashley.
R. F. Tucker	Hamburg	Ashley.
D. Wing & Bro	Rogers	Benton.
George Cannon	Rogers	Benton.
J. H. Ryan	Batavia	Boone.
G. A. Gamble	Harrison	Boone.
John B. Watson	Jersey	Bradley.
E. R. Ray	Eureka Springs	Carroll.
C. R. Adams	Corning	Clay.
J. D. Budd	Magnolia	Columbia.
B. T. Nisbett	Jonesboro	Craighead.
M. Frank H. Smeltzer	Van Buren	Crawford.
J. A. Campbell	Van Buren	Crawford.
D. M. Thompson	Vanndale	Cross.
Job Hyde	Tiller	Desha.
J. D. McDermatt	Tripps' Station	Desha.
S. J. Mathews	Monticello	Drew.
A. J. Wilson	Monticello	Drew.
M. E. Moore	Greenbriar	Faulkner.
A. M. Poole	Ozark	Franklin.
W. M. May	Hot Springs	Garland.
G. T. Johnson	Paragould	Green.
Dr. A. G. Clyne	Bethel P. O	Green.
Ransom Gulley	Melbourne	Izard.
W. J. Arnold	Melbourne	Izard.
Dr. M. M. Erwin	Auvergne	Jackson.
Jesse Cowan	Oark	Johnson.
J. A. Miller	Richmond	Little River.
J. T. Boland	Rocky Comfort	
S. H. Perkins	Booneville	Logan.
W. K. Wellborn	Paris	Logan.
J. D. Starett	Ward	Lonoke.
Wm. Carlock	Huntsville	Madison.
Lewis E. Parker	Aurora	Madison.
R. W. Perry	George's Creek	Marion.
E. L. Cox	Texarkana	Miller.
S. S. Semmes	Osceola	Mississippi.
R. S. Kilgore	Killgore	Newton.
J. H. Murphy	Mt. Parthenon	Newton.
C. F. Garbraugh	Ellcott	Ouachita.
W. E. Jenkins	Camden	Ouachita.
G. T. Holmes	Nimrod	Perry.
A. G. Garman	Barton	Phillips.
M. N. Spencer	Harrisburg	Poinsett.
D. J. Sossaman	Cove	Polk.
A. W. Mathews	Holly Bend	Pope.
A. M. Reinhardt	Hickory Plains	Prairie.

ACKNOWLEDGMENT—Concluded.

NAME.	POSTOFFICE.	COUNTY.
J. L. McDaniel	McDaniel	St. Francis.
John Schopp	Waldron	Scott.
William Stromberg	Ft. Smith	Sebastian.
G. H. Coleman		
Jacob Schales	Evening Shade	Sharp.
R. M. Brayler	Timbo	Stone.
S. C. Baskin	New London	Union.
J. C. Wright	El Dorado	
C. E. Pleas	Clinton	Van Buren.
R. J. Winn	Judsonia	White.
A. L. Stowell	Beebe	
Mrs. T. R. Roddy	Augusta	Woodruff.
W. W. Clinton	Dardanelle	Yell.

J. T. STINSON, *Horticulturist.*

Notice.—The spring of 1892 was very unfavorable for all field experiments, especially so at the Pine Bluff Station, all cotton experiments and many other experiments there were destroyed by cold and excessive rains in the spring. A brief practical treatise is given in this Bulletin on sorghum and sugar cane growing and syrup making. It is believed the information will be of some assistance to farmers in making syrup and crude sugar on small scale. Both sorghum and sugar cane will grow abundantly and of good quality in Arkansas, especially sorghum, which grows luxuriantly over the entire State. Sugar cane, however, will only grow profitably on suitable soil south of the Arkansas River from the Indian Territory to Little Rock, then south of a line from Little Rock to Memphis. In the extreme southern part of the State it grows very fine.

R. L. BENNETT, *Director.*

Experiments at Pine Bluff Station.

C. L. Newman.

CANTALOUPES.

Thirteen varieties of cantaloupes were planted under similar conditions to determine their relative merits. The ground was turned over deep in February. In the middle of March the rows were marked off 8x8 feet and hills opened with hoe and half a peck of compost (equal parts stable manure and cotton seed well rotted) put in them. Earth was then pulled up over compost with hoe to the height of about one foot. These hills were allowed to remain undisturbed until the seed were planted, April 13th, when they were raked off to nearly a level and seed put in half an inch deep. The cultivation was frequent and shallow and continued until the vines had run about two or three feet.

No. of Plot.	NAME.	First Ripe Melon.	POUNDS. Average Weight.	POUNDS. Largest Melon.
1	Baltimore	July 18	2.26	4¼
2	Delmontico	" 25	4.87	8
3	Emerald Gem	" 18	1.32	2½
4	Golden Netted Gem	" 20	.94	1½
5	Green Montreal	" 25	4 02	7¼
6	Hackensack	" 25	3.30	8¼
7	Hybrid Bay View	" 22	3.40	7¾
8	Jenny Lind	" 12	1.25	3¾
9	Long Island Beauty	" 22	2.07	4
10	Montreal Nutmeg	" 25	3.16	5¾
11	New Giant	" 24	4 98	11¼
12	Netted Green Citron	" 13	1.75	4¾
13	Nixon	" 20	2.80	7½

Varieties of Corn.

Seven popular varieties of corn were planted on equal areas and subjected to the same treatment. With these a plot each of common yellow and common white corn were planted. The object was to determine the relative yield of the corns planted and to secure a good variety for future use. A comparison of the varieties that made the least and the greatest yield is interesting. Hickory King made 22 1-10 bushels to the acre, while Welborn's Conscience made 40½. The Hickory King made very near two ears to one of the Welborn's Conscience, but the latter almost doubled the *yield* of the former. The Hickory King has a large, round and flat grain, and the cob is so small that frequently *a grain* would completely cover its transverse section. The Welborn corn has very long gourd-seed grain, some of them three-fourths of an inch in length. The Hickory King has eight and ten rows of grains. The Welborn from sixteen to thirty-four.

These comparisons are made to call attention to the fact that there is no advantage in a small cob. The greater the diameter of the cob the greater quantity of corn is it capable of holding. A cob an inch in diameter has twice the room for corn on its surface as has a cob with half an inch diameter.

The following table gives the yield and value of the varieties per acre:

No. Plot.	NAME OF CORN.	Yield per Acre.	Value of Corn per Acre at 50c per bushel.
1	Allen's Mammoth	31 3-10	$15.65
2	Golden Dent	29	14.50
3	Golden Beauty	27 4-5	13.90
4	Hickory King	22 1-10	11.05
5	Mastodon Yellow	29 1-5	14.60
6	Common Yellow	31½	15.75
7	Common White	23½	11.75
8	Welborn's Conscience	40½	20.25
9	White Dent	27	13.50
	Average Yield	29 1-10	
	Average Value		14.55

Does It Pay to Select Seed Corn?

Breeders of live stock have long recognized the advantage derived from the careful selection of, both males and females from which to breed. The judicious selection of parents from generation to generation has brought the modern breeds of live stock to their present degree of perfection and promises that the development will go much further. Every few generations some cow has a butter or milk record that excels all previous ones; a beef animal or hog weighs more than any of his kind before him, or a race horse lowers the record. These animals have been bred with a special object in view, as is generally known. Every farmer who has given attention to the breeding of live stock recognizes the importance and profit attending the selection of stock from which to breed. But few of them attach any importance to the selection of seeds. As marked results have been attained from "breeding" members of the vegetable kingdom as of the animal. Our common garden tomato was originally about the size of quail eggs. They are grown now to weigh three pounds. The Irish and sweet potatoes were no larger than small radishes; now they weigh several pounds; and so on with hundreds of plants. By carefully selecting his own seed, any farmer can improve the quality and yield of the majority of the plants he cultivates. It is often said that the seed of certain varieties have "run out." This running out or deterioration may be brought about in several ways, such as poor land, poor cultivation, change of climate, etc., but with farmers it is more due to neglect in the selection and saving of seed and allowing seed, when selected, to become crossed or hybridized with other and inferior seed than to anything else. Very marked results are occasionally reached by one effort, but when the selection is continued for a few years the resulting improvement is great in the majority of cases.

Last spring five bushels of white and five of yellow corn were shucked and a peck of shelled corn selected from each lot. A peck each from the white and yellow was then shelled, but no selection was made. In selecting the first lot, the largest, heaviest and best-filled ears were chosen and the middle and large ends only used for seed. The second lot was indiscriminately taken from the same piles and the same portions of the ears shelled. Four plots of 1-10 acres each were prepared, planted, cultivated, and in all respects received the same treatment. The following is the result of the experiment:

	Yield per Acre.
1—White Corn, seed selected	33¾ bushels.
2—White Corn, not selected	29½ bushels.
3—Yellow Corn, seed selected	36¼ bushels.
4—Yellow Corn, not selected	34¼ bushels.
Increase yield of white	4¼ bushels.
Increase yield of yellow	2 bushels.
Average increase	3⅛ bushels.
Profit of selected at 50c per bushel	$1.56¼ per acre.

What Part of the Ear is Best for Seed?

A number of well developed ears of white corn were selected and cut into five equal parts. Each end and the middle section were planted separately on equal plots and cultivated alike. The yield per acre is given below. Farmers in shelling their seed corn frequently do not use the grains from the large end but only from the middle This test indicates that the large end is the best:

	Yield per Acre.
Large end	34 2-10 bushels.
Middle	30 8-10 bushels.
Small end	30 6-10 bushels.

What Does It Cost to Make a Bushel of Corn?—Can I Buy Corn as Cheap as I Can Raise It?

These questions are frequently asked by the cotton planters of the Arkansas River Valley, but their answers may not be the same each year, but depend upon (1) the yield per acre, (2) the price paid for labor, and (3) the price of

corn. To plant and cultivate an acre of corn that will produce twenty bushels costs practically the same that it would to plant and cultivate an acre that will produce forty bushels. The difference of cost is in the gathering. If it costs eight dollars to make and one dollar to gather twenty bushels from one acre the profit will be but *one dollar* per acre if the corn is sold for fifty cents per bushel. On the other hand, if the acre produces forty bushels and sells for the same price, the profit will be *ten dollars*.

To get accurate data on the subject one acre of soil, medium in fertility, was selected and the exact cost of cultivating in corn recorded. In 1891 the ground was in cotton and with the exception of cuckle burs and occasional bunches of Johnson grass, the cotton was laid by clean. The cotton rows were three and a half feet apart. The ground was broken with a one-horse plow by bedding on the middles of the cotton rows. The corn rows were marked off across the beds with bull-tongue. These rows were three feet wide, leaving the corn hills three and a half by three feet. The corn was dropped in water furrow and covered with light furrow of turning plow. The first plowing consisted of three furrows, with solid sweep, and in the direction of the old cotton rows. It was then hoed and thinned to one stalk to the hill. The second plowing consisted of two furrows run with surface harrow (cultivator) in opposite direction from first. The second hoeing was then given it. The third plowing was with surface harrow. The plow run in same direction as in first plowing, but only one furrow to the row. This completed the "lay by."

The cost of labor this year has been sixty-five cents per day. The cost of mule and plow is charged the same. No deduction is made for land rent, but the actual expenses charged the account:

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Bedding	$1.30
Marking rows	.32½
One-fourth bushel of seed	.15
Dropping	.10
Covering	.32½
First plowing	.97½
First hoeing and thinning	.65
Second plowing	.65
Second hoeing	.65
Third plowing	.32½
Gathering	1.40
Total cost	$6.85
Thirty and eight-tenth bushels at 50c	15.40
Profit per acre	$8.55
Cost per bushel	.22¼
Profit per bushel	.27¾

Fifty cents per bushel is taken as the price of corn, believing that to be about the average selling price throughout the year. Had the acre produced forty bushels, the profit per acre would have been $13.15 and the cost per bushel would have been a fraction over seventeen cents.

Respective Yields per Acre of Staple Farm Plants on Pine Bluff Station for 1892.

		Yield per Acre.
1—Teosinte		15,250 lbs.
2—Corn, ear		25 bu.
3—Sorghum	Stalks	18,450 lbs.
	Seed or tops	1,920 lbs.
	Fodder	1,220 lbs.
4—Field Peas for Hay		7,650 lbs.
5—Sweet Potatoes		174¾ bu.
6—Johnson Grass		16,750 lbs.
7—German Millet		1,250 lbs.
8—Corn (for forage)		8,415 lbs.

SORGHUM.

As a rule land that will produce a good crop of corn will also produce a good yield of sorghum, both plants being fibrous rooted and having a similar growth. Stiff soils, soils that are inclined to "bake" or "run together" should, however, be avoided. Clay loam or sandy loam are good, and better if containing a fair per cent of lime. New ground is good, particularly when it has for a year or two been cultivated. If worked the first year, difficulty is experienced in

securing a good stand and the cultivation of the young plants is not so easy. Upland with a clay or limestone subsoil and deep pliable soil, produces well. The soil should be deep, neither very poor nor very rich and with good drainage. A southern or southeastern exposure is better. If convenient it will be well to have the field protected from the strongest winds by woods or elevated ground to prevent lodging. Better preparation is secured by fall plowing. This may be done either by broadcasting or by throwing into beds and re-bedded in the spring. In either case the plowing should be deep and thorough. Thorough and deep preparation is insisted upon. Deep cultivation after the plants have reached a few inches in height breaks the roots and checks the growth.

The best variety of sorghum for any given locality must be determined in the locality itself; but Link's Hybrid and the Early Amber seem to have given the best general results. They require the same length of time for maturity. The Liberian and Early Orange varieties have also been recommended as superior. There is a vast number of varieties, some requiring only 90 and some 135 days for reaching maturity. Link's Hybrid and Early Amber planted in the middle of May will be sufficiently matured for grinding by the middle of August. In Arkansas it is of great advantage that the syrup making should take place in August, for during that month there is less farm work to be done than during any of the other summer or fall months. Corn is not ready for gathering and cotton has been laid by. Sorghum seed may, however, be planted as soon as danger from frost is over.

As sorghum seed are small and the young plants delicate the preparation immediately before planting should be careful. If fertilizer is to be used, avoid fresh animal manures. We consider a *well rotted* compost of stable manure, cotton seed and phosphate the best, and would recommend four parts each of cotton seed and stable manure and two parts phosphate; or,

	Pounds.
Cotton Seed	800
Stable Manure	800
Phosphate	400
Compost	2,000

Open the row with turning plow, running two furrows to the row; put down manure and cover with two furrows. The ridge thus formed may be opened with a small bull-tongue or scooter point and the seed covered with same; or with a V harrow; or the ridge may be harrowed or raked off and the seed planted with hoe. If the soil is in good condition, planting with plow is as good as with the hoe and much quicker. Do not cover seed too deep, one-half to one inch is sufficient depth. More than an inch is too deep unless the planting takes place when the soil is dry. The seed may be planted either in hills or in the drill. The rows may be from two and a half to four feet wide and the stalks from six inches to two and a half feet in the drill. When the hills are more than six or eight inches apart from two to six or eight stalks may be left in the hill. The planting may be in check, two and a half by two and a half feet, and from six to ten stalks left to the hill. The advantage of check is that the cost of cultivation is reduced and the cultivation is more thorough. The width of the rows and the distance in the row must be determined by the character of the soil and the variety of sorghum planted. Seed should be put down in quantities sufficient to make it unnecessary to replant, as the replanted stalks will not mature with the others. The quantity of seed required for an acre varies from two to four pounds according to width of rows and distance apart in drill. As is the case with corn, the more fertile the soil the thicker may the plants be left. Young sorghum plants grow off very slowly and are delicate. Cultivation with both hoe and plow should begin as soon as the plants appear and be frequent and thorough, but shallow. Deep plowing after the plants

have attained a height of eight or ten inches is injurious, as their feeding roots are near the surface of the soil in large numbers. When from two to six inches high, then allow a stand of from one to six or eight to the hill, the number being determined by the fertility of soil and distance of rows and hills. While young, the plants should be kept free from grass and weeds, and care should be taken when removing weeds or grass from near the plants as they are easily uprooted. The surface of the soil should be kept loose by stirring as soon after each rain as the ground is sufficiently dry. The loose surface soil acts as a mulch in retaining moisture, and the stirring after rains kills the young weeds and grass as they appear and before they have done damage. When the plants have attained a height of from two to three feet they are generally able to take care of themselves, but should the rows become foul one or two *shallow* furrows may be run with a heel sweep and the noxious growth further killed with the hoe. "It is desirable to prevent suckers from growing if possible. It is, however, doubtful whether the evil they do is entirely remedied by removing them after they once appear. The best thing is to avoid or remove the conditions that give rise to them. The conditions are undoubtedly superfluous wealth of soil, coupled with excess of moisture, causing an exuberance of vegetable growth. The most natural method of remedying the evil produced by excess of moisture is to plant only on rolling or well drained land. With regard to the richness of the ground, it is not believed that with proper drainage there will be any difficulty from it, no matter how rich, but it would be well to plant with reference to the quality of the soil and allow as much cane to grow as it will properly sustain without suckering, so that the capacity of the soil may be fully employed in developing the full growth. By these means it is believed that suckers may be entirely prevented and the crop of cane improved."

A great advantage in the time of harvesting sorghum is that it reaches the harvesting stage after the cultivation of our staple crops has ended and before the gathering or harvesting begins.

Sorghum should be harvested and ground as soon after the seed are well in the dough as possible and before they become hard or mature, which requires from three to four months from planting. Some varieties mature earlier than others.

There is a difference of opinion regarding the stripping or removing the fodder of sorghum. Some claim that unstripped sorghum makes more and a better quality of juice than the stripped; others, that it makes more juice but of an inferior quality. But, it is generally acceded that the stripped, if it does make a little less juice than the unstripped, the juice is convertable into clearer, richer and more palatable syrup. The value of the strippings as fodder is certainly greater than the cost of stripping. But stock eat sorghum fodder with less relish and avidity than they eat corn fodder or good hay, and the sorghum fodder is not so nutritious. The fodder may be stripped by hand as corn fodder, or with a short and flattened stick. It may also be first cut, piled and the blades raked off with a long prong rake or potato hoe, and the fodder left until cured. The seed heads may be cut before or after the stalks are cut; but it is quicker and more economical to remove the heads after the stalks have been cut and piled. They should be allowed to thoroughly dry before storing. In all cases the sorghum should be worked or ground as soon as stripped, cut, or the heads removed, as evaporation immediately takes place and is soon followed by fermentation. But if ground without stripping the leaves should be allowed to wilt; if ground fresh with the unwilted leaves neither the color nor the flavor of the syrup will be so good.

Sugar Cane.

Very little sugar cane is grown in Arkansas, and that little only in the most southern counties. There is no reason why it should not be more extensively grown on a small scale in the Counties of Little River, Hempstead, Nevada, Ouachita, Calhoun, Bradley and Drew, and the six counties south of these and bordering upon Louisiana. The average date of the last killing frost in these counties is about March 15th, and the average date of the first killing frost in the fall is about November 15th, giving eight months without frost. But putting the average at seven and a half months, we have time enough for the cane to reach sufficient maturity for the manufacture of both syrup and sugar, but it is difficult to make a real first-class sugar from cane that is not more mature. A superior syrup is easily made from cane seven months old, if the conditions are favorable for the cane to secure a good growth in that length of time.

Sugar cane makes no *true seed*, but the *stalks* are planted, and when preserved for planting are technically called *seed*. One of the greatest difficulties experienced by cane planters is preserving the cane through the winter to plant the next crop. It may be planted in the fall or kept until spring and then planted. In moist or imperfectly drained soil, the planting should be done in the spring; if the soil is dry and well drained, in the fall. When the planting is to be done in the spring, the stalks are cut and piled between the stubble rows with all the leaves and trash adhering. They are placed with the tops all pointing in the same direction and covering the butts in such a manner as to leave only the tops or leaves visible. This affords a protection for the stalks. Four furrows with a large turning plow are now thrown upon the windrow, and the process of covering further perfected with the hoe by pulling the loose soil so as to completely cover the cane. When the cane is taken up for planting, the

soil is thrown from the windrow with a turning plow, and the stalks pulled out with a hoe or pick. If the cane is planted in the fall, it should be covered with several inches of soil so as to thoroughly protect from the cold. After it is covered, it would be well to run a roller over the row to press the earth well against the stalks. If the soil is either too wet or too dry, the cane is liable to rot. The extra covering of soil used upon the fall-planted cane should be removed early in the spring so as to secure early germination, thereby lengthening the season of growth as much as possible, that the per cent of saccharine matter may be greater. The cane is planted in a well opened furrow by placing a continuous row of stalks in the furrow and covering with four or five inches of soil, if planted in fall, and two or three inches if planted in the spring. If the soil is very furtile, two rows of stalks may be planted together and so placed that the stalks of one row will lap across the ends of the stalks of the other row, the middle of the stalks of one row being opposite the ends of two stalks in the other. To continue cane on the same land the roots of the preceding year's crop can be used for seed; place the fodder when stripped from the cane over the roots and before freezing weather run two turn plow furrows on each side of the roots to cover the fodder on them. In the spring remove the soil and fodder, and put in the furrows next the roots some good fertilizer. One-half to three-quarters of an acre of good soil will make a year's supply of good sorghum or cane syrup for an average family. When cane first appears, its growth is slow, during which time tillering or multiplication of stalks is going on. While the process of tillering is going on, the soil should be frequently stirred with the harrow or plow. When the period of tillering is passed, the growth of the cane is rapid, and cultivation should be frequent and thorough and continued until the cane has attained a growth sufficient to shade the rows and prevent growth of grass and weeds.

Of the three varieties of cane cultivated in the South, only two can be recommended—the violet or purple cane and the ribbon or striped cane. The green or white cane is not worthy of cultivation for either sugar or syrup.

The prevalent method of cultivating corn is considered best for both sugar cane and sorghum. The width of rows varies from five to seven feet.

Nitrogen, phosphoric acid and potash are the fertilizers used for cane, but the latter only upon light, sandy soils. The best and most economical sources of nitrogen are cotton seed and cotton seed meal. Nitrogen hastens the growth and maturity, but an excess should be avoided as it decreases the percentage of sugar. Phosphoric acid is always beneficial when applied in a soluble form. The fertilizing materials may be applied in the form of a compost or separately. A good compost may be made as follows:

	Pounds.
Cotton seed meal	1,200
Phosphoric acid	600
Kainite	200
Compost,	2,000

If cotton seed are used instead of the meal, the proportion should be about twice as much seed as meal for the same quantity of phosphoric acid. These composts may be applied in quantities ranging from 400 to 1,000 pounds per acre. The fertilizer should be well rotted if applied in the spring. This is not so essential if applied in the fall. When ready for harvesting the fodder is stripped, tops removed and the stalk cut near the ground. A convenient cane knife is made for this purpose and has a projection from the back with which to strip the fodder. For convenience in hauling the stalks are thrown into every third middle. The cart is driven between and loaded from each side. If the cane is intended only for syrup it should be topped about the first white or unmatured joints, but lower down if sugar is to be made. The stalks should as far as possible be cleaned of all leaves and sheaths before the cane enters the mill.

Syrup and Crude Sugar Making.

The ordinary process of syrup making is very simple and inexpensive. A mill and evaporator, with a few tanks and small utensils are sufficient, so there is little excuse on account of apparatus for any farm being without syrup or having to buy it. A small outfit is sufficient to make the syrup and crude sugar supply for three or four families. Good pure sugar cane syrup and even sorghum cannot be bought in all markets. Usually an inferior grade of molasses or a chemically prepared substance is sold for syrup. The prices paid for good syrup are sufficient to make the manufacture of syrup profitable, aside from the manufacture for home consumption. The treatment of sorghum or sugar cane juice for syrup making is the same, except that more difficulty is experienced in removing the impurities from the juice of sorghum.

All apparatus should be in readiness when the grinding begins, and scrupulously clean. The mill and evaporator are the principal pieces of apparatus. The mill must be substantially erected, the feed roller left slightly open to receive the stalks, but the bagasse or second small roller should be almost in contact with the main roller, otherwise good extraction cannot be expected. This refers to a three roller mill; two roller mills should never be used; they are *absolutely worthless*. The mill is the principal piece of *machinery for the maximum yield of syrup, and only strong mills of three rigid rollers, in a strong iron frame, should be used.* A tight box or barrel should receive the juice as it comes from the mill, through a *good strainer*, which catches the fragments of cane and other impurities not in solution. The straining is very important and should receive especial attention. A good cheap strainer can be made as follows: Make a wooden box four to six feet long and sixteen inches wide and sixteen inches deep. Bore one hole in one end near the

top. Fill the box with clean straw, tightly packed; this completes the apparatus. Allow the juice from the mill to enter the box from one end and to pass out the top hole in the other end. The flow of juice is almost imperceptible through the six feet of sixteen inch square filtering surface. All impurities are deposited and held by the straw as the juice percolates slowly through it. The juice comes out pure and almost transparent, and consequently will require less skimming and is a saving of juice. A purer, brighter syrup is made thereby. The box will require cleaning with water about twice a day. The straw should be taken out and run through the mill to press out the juice and new straw put in the box.

Cane juice soon spoils when pressed from the cane and exposed to the air, and because of that fact juice must be worked up as soon as possible. The quicker it is placed in the evaporator and heating begins the better. The juice is taken from the strainer to the evaporator and cooking is commenced. Then the impurities rise to the surface and form a scum, which is removed with a perforated ladle. Cooking and removing the scum continue until the consistency of syrup is reached, at which point it will practically weigh about 11½ pounds per gallon. The evaporators should be arranged to facilitate the removal of the scum. Special designs are made for that purpose.

The cooking should consist of three divisions: First, slow heat, to remove impurities or scum; second, increased heat, to remove remaining impurities and to reduce the juice to semi-syrup; third, higher heat to finish to syrup. Practically, when the syrup stage has been reached it can be recognized, after having been seen once, by its action and color while cooking. A good simple test for determining when the proper consistency of the juice for syrup has been obtained is by putting a small quantity of the boiling liquid in a saucer and allow to cool.

If sugar is to be made, the concentration continues until the syrup has reached a density of about 40° Baume, or a boiling point of about 240° Fahrenheit. It is then transferred to barrels or boxes with perforated bottoms and stirred to hasten granulation. The molasses drain through, leaving the crude sugar in the barrel; or the concentrated syrup may be transferred to shallow coolers and after two to four days the molasses drained through Osnaburg sacks into barrels or tubs over which the sacks are suspended. Centrifugal separators are made for the purpose of removing the molasses from the sugar. The sugar, after separation, may be packed in either sacks or boxes.

It is very difficult to make sugar from sorghum, and there is great danger of burning in open fire pans either sorghum or cane juice when highly concentrated. Steam heating is best. To make high grade sugar, large and expensive machinery is required and much skill to successfully operate the plant, therefore it is hardly possible on small farms.

LIMING.

In high grade syrup or sugar making it is necessary to lime or deficate the juice. The object of liming is to neutralize the acids and with heat remove the impurities of whatever nature and prevent the jelly-like substance in the syrup. *Liming must be done carefully and cautiously or failure will result*, and it should not be undertaken unless care is to be observed in all details. Two barrels or tanks should be provided to receive the juice from the strainer for liming. The best form for adding the lime to the juice is by stirring caustic lime and cold water together until the consistency of new milk is obtained, care being taken not to use too much water. Then let stand two or three minutes to allow heavy particles to subside. The fluid may then be applied at the rate of two to three gills to every fifty gallons of juice and stirred to

thoroughly incorporate. When a sufficiency of lime has been added it can best be determined by the use of test paper —blue litmus paper, which, when dipped into the juice, changes from blue to red. The addition of lime should cease just as the change of color is complete, leaving the juice neither acid nor alkaline. The addition of an excess of lime is determined by the red color of the paper changing back to blue. The excess of lime is corrected by adding more fresh juice until no change is made in the paper from one color to the other. The sediment having subsided after the addition of lime, the juice is drawn into the evaporating pan and cooking begins.

Apparatus for Syrup and Sugar Making.

The outfit required for making sugar and syrup from sugar cane and sorghum on a small scale consists of the following pieces of apparatus: A horse or steam power mill, with timbers to erect it; one evaporating pan, made of galvanized iron or copper, with a portable furnace or made to suit one built of brick; three barrels or tanks, for juice; one strainer; two skimmers, if the evaporator is not an automatic skimmer; test paper for determining when the proper quantity of lime has been added, by revealing the presence of an acid or an alkali in the juice.

An interesting and useful though not an essential instrument is the saccharometer. It is employed for determining the amount of sugar or saccharine matter in pure juice. The instrument is very delicate and the scale is graduated for juice at 60° temperature. They are inexpensive.

Evaporators and mills are made for different capacities and with different convenient advantages. For instance, a self-skimming evaporator, which is very economical, and one with a capacity of from fifty to sixty gallons of syrup per day will cost about $60.00, copper pan. A heavy one-horse vertical three-roller mill, strongly built, of the same capacity as the evaporator, will cost $32.00. A good light one-horse mill, of thirty or forty gallons ca-

pacity per twelve hours, can be had for $21.00, and an evaporator of same capacity, plain and of heavy copper, will cost about $30.00; or it can be made just as good at home at a tinner's for less than that. All other necessary apparatus cost little. Brick or rock furnaces are inexpensive. An evaporator with a portable iron furnace of thirty or forty gallons capacity in twelve hours will cost about $51.00. These furnaces are especially advantageous for traveling with an outfit from one farm to another.

Before purchasing an outfit, several manufacturers should be written to for prices and descriptive catalogues. Local dealers usually charge excessive prices for mills and evaporators. By selecting from catalogues from several reliable manufacturers the cheapest and most improved apparatus can be secured, and only the best should ever be bought. Directions for erecting and operating usually accompany the outfit. The following reliable manufacturers will furnish prices, information and illustrations of mills, evaporators, etc.:

The Blymyer Iron Works Co., Cincinnati, Ohio, manufactures mills and the Cook Automatic Evaporator.

L. M. Rumsey Mfg. Co., St. Louis, Mo.

Mansur & Tibbetts Implement Co., St. Louis Mo.

COTTON EXPERIMENTS AT NEWPORT, 1892.

R. L. BENNETT AND G. B. IRBY, ASSISTANT.

Rotation of Crops to Maintain and Restore Fertility to Worn Soils.

The general plan of the experiment and two years' results are reported in Bulletin 18 but briefly, the object of the experiment is to ascertain *if worn cotton and corn lands could not be improved without the use of any kind of manures and at the same time yield a profit.* The first two years' results are exceedingly satisfactory and favorable to attaining the object for which the experiment was begun, and the third year's results add additional confirmation to them.

The three years experiments are exhibited and are worthy of study.

FIRST YEAR.

NO. PLATS.	PLANTS AND METHODS OF TREATMENT.	YIELDS PER ACRE.	PROFITS.
1	Cotton	830 lbs	$ 8 00*
2	Field peas; peas picked (Pea vines turned under and barley sown in fall	33⅓ bu.	30 00
3	Field peas; peas picked (Pea vines allowed to remain on soil).	33⅓ bu.	30 00

SECOND YEAR.

1	Cotton	700 lbs.	$ 5 96
2	Barley; cut hay 1,500 pounds, value $5.00; (planted in cotton and omitted because of error in picking).		
3	Cotton	950 lbs.	11 25

THIRD YEAR.—(Bad Season).

1	Cotton (only ⅔ stand)	431⅞ lbs.	$ 3 00
2	Peas; peas picked	17⅓ bu.	15 60
3	Corn	22⅖ bu.	12 64
	Peas in corn; peas picked	6⅔ bu.	

*The value and expense used in calculating profits are purely arbitrary, and calculations are made simply as convenience for comparison.

It appears from the results that by a proper system of rotation of crops we can maintain or increase the fertility of the soil and consequently secure an increased production without cost. A considerable outlay of money, however, would be required to accomplish the same results with commercial fertilizers, while little, if any, permanent good to the soil remains from their use, and that is relatively small when compared with the benefits from the use of vegetable matter. During our long, hot summers vegetable matter applied to the soil exerts beneficial effects in many ways on both the growing crops and the soil, and because of the long growing season the staple crops of the State do not require a fertilizer to be readily available as is commonly the case with commercial fertilizers.

Effects of "Farm" Manures or "Home Made" Manures on Worn Sandy Cotton Land.

The soil used was worn sandy cotton land that had never been fertilized since the beginning of its continuous forty years cultivation in cotton and corn. Three one-acre plats were planted similarly in cotton. One plat had no application of manures; the second plat had pea vines turned under after picking off the peas, and, in addition, 1,604 pounds of cotton seed. The third plat had the manure from feeding 1,604 pounds of pea hay and 1,604 pounds of cotton seed. Each plat was planted in cotton. The table exhibits results:

	Pounds Seed Cotton.
Plat 1—No manure, yielded	1,008
Plat 2—Pea vines and cotton seed, yielded	1,557.8
Plat 3—Manure from feeding pea hay and cotton seed, yielded	1,454.8

The peas picked from pea vines turned under on Plat 2 paid all the cost of their cultivation and left a profit besides. In Plat 3 the cost of producing the pea hay was exceeded by

the gains of the animals that consumed the hay. The manure of Plat 3 caused the cotton to grow throughout the season, delaying its maturity and consequently its yield, which was reduced probably 8 per cent by boll worms and an early frost.

The production of "home made" manures and their use afford additional evidence to that of the rotation experiment, that commercial fertilizers are not necessary for our crop because the lands can be maintained or increased in fertility, and increased crops produced without commercial fertilizers and the money expended can thus be saved on the farm. On most of the worn cotton land of the State, the ordinary commercial fertilizers do little good to the crop the first year, and none at all the second year. Such was the case in an experiment the past two years with acid phosphate, floats and kainit—the results are reported subsequently—the latter, however, made a good increase the first year applied at the rate of 500 pounds per acre, but there was no effect from it on the second year's crop. On the whole, they would not return their first cost on that land for cotton fertilizing, and there are few instances in the State where they will do any better. In view of the superior fertilizing material that can be cheaply produced on the farm, commercial fertilizers should be used only to a limited extent and *the mixtures, which are the most common forms in which fertilizers are sold, should not be used under any consideration.*

Whenever it becomes necessary to supplement "home-made" manures with commercial fertilizers, the needs of the soil for the plant to be grown should be first determined as indicated in Bulletin 18. If more than one of either Potash, Phosphate or Nitrogen is needed, they should be bought separately and mixed in the proper proportion by the farmer. By so doing the same quantity of valuable ingredients which are adapted to the needs of the soil will be obtained for about two-thirds the cost of the ready-mixed fertilizer nostrums.

Effects the Second Year from a Liberal Application of Cotton Seed, Cotton Meal and Commercial Fertilizers.

The plats received the previous year 500 pounds per acre of each—cotton meal, cotton seed, kainit, floats and acid phosphate. The cotton seed plat was on soil apart from the others, and is reported separately.

YIELDS 1891.

	Pounds Seed Cotton.
500 cotton meal	1,199
500 kainit	899
500 acid phosphate	832
500 floats (or ground bone)	866
No fertilizer plat	800

(See Bulletin 18 for notes).

YIELDS 1892—SECOND YEAR.

	Pounds Seed Cotton.
Cotton meal plat	1,004
Kainit	937
Acid phosphate	829
Floats	750
Nothing	1,008

COTTON SEED YIELDS 1891.

	Pounds Seed Cotton.
500 cotton seed (equal to 175 pounds cotton meal)	949
Nothing plat	700

YIELDS 1892—SECOND YEAR.

	Pounds Seed Cotton.
Cotton seed	817½
Nothing	614½

The yield of cotton meal plat in 1892 would have equaled the nothing plat if boll worms and frost had not damaged.

COTTON SEED.

This is the first season that farmers have been able to sell their seed for more than half their value. The increase in price is due to short crop and to the increased consump-

tion of oil, meal and hulls. The market price for the season has been about equivalent to the fertilizing value of the seed, but they are worth considerably more than the present price for fertilizing when fed with rough food to cattle.

Pea Vines and Pea Stubble as Soil Renovators and Fertilizers For Cotton.

The Newport Station soil is like most soils of the State in its need of plant food or renovation in some way, and vegetable matter applied seems to supply whatever is needed. During the long hot summers the soil dries out badly, and cotton suffers very much at that time, and when vegetable matter is applied, it prevents that disaster. The field pea is the only one of all the leguminous plants that will grow on that and similar soils during the dry summers and protect them, and produce a sufficient growth that will be beneficial to any considerable extent. Experiments were made to ascertain to what extent one crop of pea vines turned under benefited the soil, and likewise of pea stubble after removing the vines for hay. The peas were picked from the vines that were turned under, and they more than paid the cost of production. Cotton was planted on the two plats, and, for comparison, on a third one untreated. The increased yields by pea vines and stubble are at the same rate as the increase from pea vines reported in Rotation Experiment, Bulletin 18, and also by other experiments of the same nature.

	Pounds Cotton Seed.
Yield pea vine plat per acre	1,409
Yield pea stubble plat per acre	1,291
Yield no-treatment plat per acre	1,008

The following cut fully illustrates the experiment:

Without Peas. Yield 1000 Pounds. With Peas. Yield 1400 Pounds.
Forage on soil without peas, and on soil With Peas the Previous Year.

Economy of Feeding Pea Hay and Cotton Seed to Stock Before Using for Fertilizing.

Stock feeding and fertilizing are mutually dependent upon each other for their success, and the rational practice of each is of great economic importance. In Arkansas the field pea and cotton seed are respectively the most important and valuable materials for fertilizing and stock feeding. They are important because of their richness in plant and animal food. Cotton seed contains an oil that is of no value for fertilizing and is lost when so applied, but it is valuable as an animal food. Pea hay is rich in albuminoids, which are valuable for animals and plants and when fed to animals nothing is lost from their value for plant food. True economy suggests then that pea hay and cotton seed be first fed to stock before they are used for fertilizing. To ascertain the extent of the merits of feeding the material to animals before applying as a fertilizer, one-half acre of land was sown in rows with whippowil peas in 1890, they made a good yield of both peas and vines. The peas were picked from one-half of the plat and the hay or vines on that half were allowed to remain on the soil for protection from the alternate freezes, thaws and rains occurring during the winter. The vines on the other quarter acre were cut and cured for hay with the pods on, yielding 426 pounds of *dry* hay. The soil was not winter broken nor prepared for planting until just before the date for planting. While it is advantageous to turn the soil in February for cotton it was omitted in the experiment, because if it had been turned and the extra amount of vegetable matter allowed to thoroughly decay on the plat of unremoved vines its yield in excess of the other

plat if any would have been in part attributable to that instead of the point in question. In March 852 pounds of cotton seed were divided into two equal lots of 426 pounds each. One lot was put in condition to destroy the vitality of the seed; the other lot with the 426 pounds of pea hay was fed in stall to one three year old steer. The steer was secured from the range, where it had been the entire winter without food except the inferior stuff it found on the range, so at the beginning of feeding the animal was in very poor condition, "*hide bound.*" Much feed was required at first to get the animal in a normal condition, and consequently no gain resulted from the food fed for the first few days. The feeding period was short, though the gain of the animal for the period was good. The feeding continued 42 days and the total gain was 123 pounds or 2.92 pounds per day. The urine was absorbed by soil taken from the plat which was to receive it, and the soil was returned to the plat with the manure. The feeding was completed just prior to the date for cotton planting, so the manure was *green* when applied to the soil. The two plats were prepared and the manure and cotton seed were each applied to their respective plats in the drills for cotton.

The cotton on the manured plat grew slower at first than that on the other plat, but the growth was steady, and it retained a green, vigorous color and continued to make stalk and fruit until frost. The pea vine and cotton seed plat's growth was rapid from the first and began an early and rapid fruitage. It did not remain green and continue growing throughout the summer, but matured its fruit early and then ceased growing. The dates and amounts of each picking show fully the progress of development of the two plats.

DATES OF PICKING COTTON.

Pea Vine and Cotton Seed Plat.	Manured Plat.
October 1, 25 per cent open.	October 1, 3 per cent open.
October 11, 181.6 pounds.	October 11, 73.93 pounds.
November 19, 181 pounds.	November 19, 244.68 pounds.
December 9, 26.8 pounds.	December 9, 45.07 pounds.
Total, 389.4 pounds.	Total, 363.7 pounds.

The yields of the pea vine and cotton seed plat exceeds the manured plat, but the reverse would in all probability have been the case if the growing season had extended its usual length, the first frost was at least two weeks earlier and the crop two weeks late, because of the cold spring, so the late maturing manured plat was much damaged both by frost and boll worms. The manured plat exceeded the other plat in growth and its fruitage was much superior.

DATA OF THE EXPERIMENT.

Pea Vine and Cotton Seed Fertilized.	Value of products.	Cost.	Manure from Pea Hay and Cotton Seed Feeding.	Value of products.	Cost.
Picking 426 pounds peas		$ 2.13	Cost cutting and curing hay		$ .75
			Cost labor for feeding animal		63
Value peas $1.00 per bushel	$ 6.00		Increased value of the animal's original live weight by feeding	$ 13.16	
SECOND YEAR.					
Picking 389.4 lbs. cotton		1.94	Value of the increased weight of the animal	3.69	
			SECOND YEAR.		
			Picking 363.7 lbs. cotton		1.81
Value 389.4 pounds cotton	11.68		Value 363.7 pounds cotton	10.91	
	$ 17.68	$4.07		$ 27.76	
Total	$ 13.61		Total	$ 24.57	$ 3.19

The difference in total profits in favor of the manured plat is mainly due to the increase of the marketable condition of the animal, but it is a legitimate credit. If the growing season had been longer and no boll worms had appeared the

increased yield of the cotton on the manured plat would make fully the present difference in total profits, after deducting the value of the increased marketable condition of the animal. The growing season was remarkably short, and so uncommon that such seasons do not enter into annual farm calculations.

The values of the fertilizing material remaining in the soil of each of the plats will be tested the coming season.

SUMMARY.

First, it is more profitable to feed pea hay and cotton seed to stock before applying them to the soil as fertilizers for cotton; it is more profitable to do so when the increased yields of the crop are considered alone and independent of the profits from the animals fed.

Second, the effect of *green* cow manure on cotton is to prolong its period of growth while decayed pea vines and cotton seed shorten the growing period and hasten maturity.

Selection of Seed.

It was attempted in Bulletin 18, to show by experiments that the cotton plant is readily susceptible to influences, as evidence, varieties tested under varying conditions varied greatly in their yield with respect to each other. The variableness of varieties and so-called varieties emphasizes the importance of carefully selecting planting seed from mature bolls, properly situated on well developed stalks. An experiment was made this year to determine the direct influence of selecting good seed. In this connection a reprint is made from Bulletin 18.

BOTTOM AND TOP BOLLS.

"To secure seed from well matured bottom and top bolls for experimental planting, and also to determine the differ-

ence in quality of cotton from an equal number of bolls from each section of the stalk, 500 matured bolls of Peerless were carefully picked from each section of well developed stalks, then weighed, ginned by hand and classed. The results are appended in table.

SECTIONS OF STALK.	Seed Cotton.	Per cent Lint.	SEED.	LINT.	STAPLE.
500 Bottom Bolls.....	8.26	32.11	5.61	2 65	1¼
500 Top Bolls.....	6.46	33.96	4.27	2.19	1¼

The bolls were not picked from the extreme sections of the stalk. From the data the top bolls are far inferior in production to the bottom bolls. 500 bottom bolls correspond to 637 top bolls."

The seeds from the bottom and top bolls were similarly planted in the spring, when other cotton was planted. The vitality of the young plants was fully tested by the weather which was exceedingly favorable to the test, being cold and excessively rainy. The cold and rain were so uncommon in their duration that most all field cotton was killed, or did not come up and required replanting.

The Bottom Boll Seed germinated promptly, and apparently, every seed that was planted came up and none died after coming up, but looked vigorous and grew off rapidly considering the cool weather, and were large enough for the plow before the grass became troublesome. *The Top Boll Seed* failed to germinate more than half, and of those that did germinate three-fourths were killed by the cold and rains, and even two replantings of seed failed to produce more than 50 per cent stand; the plants were too tender to endure the severity of the weather. The quantity of top boll seed re-

quired to secure a half stand was three or four times the quantity required to secure a perfect stand of bottom boll seed, and the extra cost for replanting was in proportion. The top boll seed grew slowly at first, and the cultivation required with the hoe was expensive.

The dates of maturity of the cotton from the two seeds are:

Bottom Boll, first open boll September 10th; Top Boll, first open boll, October 1st; boll worms, first appearance, September 1st; October 1st, bottom boll, 25 per cent open; October 1st, top boll, 3 per cent open.

The earliness of the bottom bolls practically placed it out of danger from boll worms and caterpillars, but the top boll was so late as to be in great danger of the worms. There was very nearly a month's difference in the maturity of each crop. Three-fourths of the bottom boll crop was picked in October before the weather was bad and before the price for picking advanced. Three-fourths of the top boll crop was not open for picking before the 17th of November, and was injured by rains and winds occurring at that time.

If the plats, which were poor had been fertilized as subsequent experiments will show, the dates of opening would have been very much earlier than they were.

YIELDS.

	Pounds Seed Cotton per acre.
Bottom bolls	1,043
Top bolls	760

Besides the decrease in yield from unselected planting seed, it also appears from the experiment that in planting cotton, much seed is uselessly wasted, which would be good for stock feed, oil or fertilizing; that there is much extra expense for replanting, hoeing and late picking; and that there is loss by worms and bad weather.

Effects of Ginning and Late Picking on the Value of Cotton.

Tests were made of *rapid ginning*, *different gins* and *early* and *late picking* after opening. The remarks and classifications, with prices affixed, were made by experts, F. A. Jones and T. P. Stoney, cotton shippers at Newport. The samples furnished were known to them only by numbers.

Effects of Different Makes of Gins on the Value of Cotton.

NAME OF GIN.	REMARKS ON QUALITY OF COTTON.
Winship Gin	Strict middling; slightly gin-cut; value 9⅛ cents.
Smith & Sons Huller Gin	Good middling; well ginned; good color; value 9⅜ cents.
Eclipse Gin	Good middling; fairly well ginned; value 9⅜ cents.

Effects of Slow and Rapid Ginning on Quality of Cotton.

Slow ginned	Good middling; good color; well ginned; value 9⅜ cents.
Rapid ginned	Strict middling; gin-cut; little off color; value 9⅛ cents.

Effects of Early and Late Picking After Opening on Quality of Cotton.

Picked few days after opening, October 7	Strict good middling; extra good color; value 9¾ cents.
Late picked; (exposed on stalk to rains and winds; picked January; 15 cents extra per hundred for picking)	Good ordinary; spotted and sandy; value 8¼ cents.

The staple was the same length in each classification.

Observations from Experiments on Varieties of Upland Cotton.

In Bulletin 18, the susceptibilities of varieties to variation was shown, and also the *worthlessness* of repeated comparative variety tests.

According to habits of growth varieties are of two divisions, *Long Limb* and *Short Limb*. The natural characteristics

of the *Long Limb* varieties are, *long limb*, *unprolific*, *large bolls*, *late maturity* and *long staple*.

The natural characteristics of the *Short Limb* varieties are, *short limb*, *medium* to *small bolls*, *prolific*, *early maturity and short staple*.

According then to their natural habits of growth, they should not be cultivated alike, but almost opposite culture should be given each. The *Short Limb* being a rapid grower and prolific, must first have a well prepared and firm seed bed. Second, an available supply of plant food. Third, frequent shallow cultivation. While the *Long Limb* is a slow grower and does not require an abundance of readily available plant food nor so frequent culture. The *Short Limb* is a direct product of high culture, and is suitable especially for high class farming. There are *variations* and *intermediates* of the Long and Short Limb varieties, and many of them of excellent merit, due of course to selection and good culture. The *early* cottons are all short fibre while *late* cottons are both short and long fibre. *Long Fibres* are rarely prolific. The true *Short Limb* and *Cluster* cotton cannot be made to produce the same length of fibre as the late maturing *Long Limb* cotton, but it appears that under circumstances as they exist in the State in a good many instances, length of staple should be sacrificed for quantity, or more strictly speaking, to sacrifice length of staple to secure an early matured and increased crop, which may be picked at low cost, and before winds and rains have done damage. The cotton will then sell for a good price. An early variety will also, to a large extent escape the destructive boll worm and caterpillar.

In improving cotton little attention has been given to the natural habits of growth, consequently slow progress is made in improving it and more difficulty is experienced in maintaining its merits; but if all cultivation and treatment of a variety be in accordance with its habits of growth, its

merits will be constantly increased and it will become more adapted to its local surroundings and the frequent buying of high priced seed of so-called new and improved varieties will be avoided.

To secure the best variety suited to certain conditions each farmer must make the test of varieties for himself on his own premises, the test will be both instructive and profitable, and by studying and noting the habits of each, it will be an easy matter for each farmer to select one of the long or short limb types that is best suited to his methods of farming and environments. A few seed of each variety to be tested will be sufficient for the test. When the variety is selected the planting seed for each succeeding year must be specially cultivated and selected according to the habits of growth of the variety to maintain and improve its merits, by so doing, the rapid improvement it will make will be astonishing.

The following cuts are presented to show the Long Limb and Short Limb or Cluster and Medium Limb cottons:

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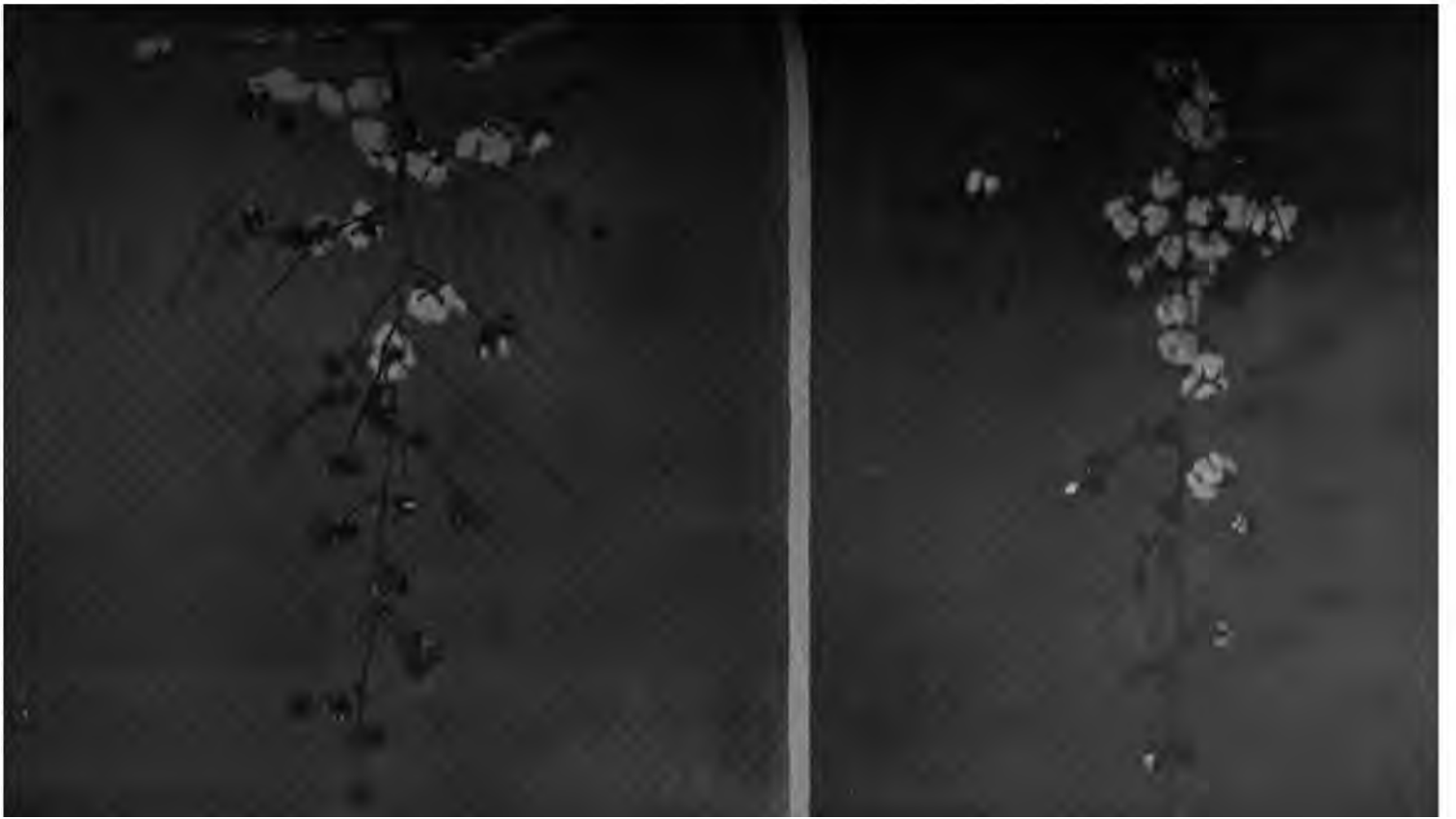

Summary of Two Years' Experiments with Cotton.

1. A proper system of rotation of crops will maintain the fertility of soils and improve worn soils without the use of any kind of manures and at the same time yield a profit.

2. It is more profitable to use cotton seed for feed and for fertilizing when they command a less price than $15.00 per ton.

3. Cotton seed selling for $7.00 per ton is more profitable for fertilizing than cotton meal selling for $20.00 per ton.

4. Before using any commercial fertilizers, it is necessary to know the demands of the soils for the plants to be grown. The analysis of the soil can be made with the essential fertilizer ingredients.

5. The values or merits of varieties of cotton depend essentially upon the culture they receive and the care in seed selection. The Short and Long Limb varieties require culture different from each other. The Short Limb should have an available supply of plant food, frequent shallow culture and the stalks close in the rows, while the Long Limb requires wider distance between stalks.

6. One year's selection of seed will improve very much. the yield, prolificness and earliness. Care in preserving seed is very important; it saves seed in planting, and success or failure of the crop depends largely upon it.

7. The *length* of *staple* is dependent upon a long growing season and an abundance of plant food, moisture and variety. Extra length can be produced only on long limb, slow maturing varieties.

8. Bottom boll seed yield more lint and seed than top bolls, and the seed from bottom bolls are far superior to top boll seed for planting.

9. The distance of planting depends altogether upon conditions, mainly the variety, whether long or short limb, and the fertility of the soil.

10. Shallow culture is preferable to deep, particularly if a good seed bed was prepared and the variety is a short limb, early maturing one. Deep culture is injurious, except in rare cases, such as to check too rapid weed growth, to break rain-packed soil when cotton is young.

11. "Home made" manures are more permanently beneficial to soils than commercial fertilizers, and are more economical. No commercial fertilizers should be used in the State, since a system of rotation with field peas, and, when possible, supplemented with home made manures, will maintain and increase the yields of soils without any outlay of capital.

12. It is more profitable to feed pea vine hay and cotton seed to stock before using as a fertilizer for cotton.

13. The effect of green cow manure on cotton is to prolong growth, while decayed pea vines and cotton seed shorten the period of growth and hasten maturity.

14. Pea vines and pea stubble increase very considerably the yield of cotton, and prevent the disastrous effects of heat and drouth during summer. The vines are superior on worn, sandy soils to a liberal supply of commercial fertilizers. Peas gathered from the vines are worth the cost of cultivation and frequently more.

15. Exposure on the stalks to bad weather reduces very much the value of the lint; ginning also influences the quality of the lint.

GENERAL CONCLUSION ON COTTON CULTURE.

Successful cotton culture demands a concentration of forces on a small area for intensive farming; which means a renovation of the soil by a rotation of crops, including the field pea as a basis, to supply vegetable matter, deep and well turned soil in February, shallow and firm seed bed on a liberal supply of home made manure if obtainable, early planting of well selected and preserved seed, sufficient distance

between the stalks, early, rapid and shallow cultivation. Such practice will avoid the necessity of much costly and unbeneficial hoeing by enabling an early growth for plowing before the grass begins to grow, and the crop will be matured and opened, ready for picking, before much bad weather. Careful cultivation and renovation will also be successful in preventing the diseases of cotton.

Boll Worm and Cotton Caterpillar.

During the two years of cotton experiments, careful observation has been made on the ravages of the boll worm and caterpillar, with a view of having the cotton crop escape them, particularly to escape the boll worm, which is far more destructive in the section infested by them during a series of years than ever is the caterpillar. The following method is indicated to those not already practicing it as a means of avoiding the worms to a great extent. The method is substantiated by observation. The boll worm and the caterpillar appear about the same period each year—that is, rarely ever earlier than a certain date. The boll worm, however, is present during the entire season, but *does not appear* very much on cotton until after there are no other more suitable plants for it to feed upon, such as corn and cowpeas. The caterpillar is not usually in sufficient force to do any damage until a late date. *So if the cotton crop is early, it will be matured before the worms appear in sufficient numbers to do it much damage.* The means to secure an early crop is by planting an early variety early and cultivate it as indicated in the General Conclusion on cotton culture. Many of the foregoing experiments indicate the advantages of an early matured crop, aside from avoiding the worms.

COTTON WEATHER NOTES, 1892.

May.—Cotton has made little growth because of the continuous cold and heavy rains.

June 6.—Weather more favorable; cotton beginning to grow and spread.

June 8.—Two days' rain and hard cold wind have checked the growth of cotton.

June 15.—Cotton late; condition very good.

June 19.—Weather favorable; condition of cotton has continued good.

July 1.—Cotton growing very well, but very late for the date because of the very unfavorable spring.

July 7.—Rainfall frequent since July 1, and has checked the growth of cotton.

July 15.—Cotton in good condition, but maturing very slowly.

August 18.—Weather has continued favorable.

September 1.—Cloudy and excessive rain for several days, and boll worms appearing.

September 7.—Much damage being done by boll worms.

The above weather observations will furnish an idea of the unfavorableness of the season for cotton development. The season so retarded development that boll worms did great damage, reducing the yield fully one-eighth by actual estimate.

Notice.

The experiments in this bulletin were all made on the Branch Station at Newport, Ark. Many people in the State have confused the point at which experiments have been made, and as the same plants will not mature the same at each of the three Stations, the confusion of location has caused some misunderstanding of reported experiments. When experiments are made at either of the two branches, Newport or Camden, it is so stated on the first page of the Bulletins. All remarks of experiments are made with reference to the conditions of this State only.

Other experiments made at Newport, 1892, will appear later.

Explanation of Terms Used in Connection with Fodder Analyses.

In a few of the first pages of Bulletin No. 19 of this Station, fourteen substances were named, briefly described and pointed out as being those elementary substances which, wholly or in part, unite in various combinations to form the soil and all animal and plant matter. Four of these constitute more than nine-tenths of the dry matter of nearly all plant products with which we meet upon the farm. The remainder constitutes the ash matter which is left when the plant is burned. Many substances containing two or more of these elements are built up only through the influence of living or organized matter and are therefore called organic substances. The same chemical elements, and in many instances the identical organic substances that occur in the plant also occur in the animal. Indeed the essential living matter of both plant and animal—the so-called protoplasam—are so nearly identical, that we can distinguish between them only by the nature of their growth. The most delicate chemical methods known show no distinguishing line between them, and throughout all living matter, that first essential portion from which all other proceeds, so far as chemistry can show, is identical.

While we recognize with readiness a wide distinction between the higher plants and the higher animals as we see them in every-day life, in the lower plants and animals, such for example as occur in the water of stagnant pools, the only vital distinguishing mark between many of them is their manner of taking food. This distinction is carried also into the higher plants and animals, and is a principle of first importance in agriculture.

By their peculiar organization the so-called plants have the power of building into organic matter the chemical elements mentioned, out of inorganic substances containing those elements. When the peculiar organization of the liv-

ing matter is such that it can take those elements as food only after they have been built up into certain organic substances, such living matter becomes an animal. In other words, the living matter of the plant produces out of inorganic material all plant products with which we meet, such as cotton fiber, starch, sugar, cotton seed oil, or, when the substances of which these are examples are united into a complete whole, a perfect apple or a grain of corn. Out of these substances the higher animals derive their nourishment and build up those animal matters which are useful to us, such as milk, meat and eggs.

The skilled dairyman can obtain from his milk, successively, the fat, which makes butter; the casein, as a curd which will ripen into cheese; and the milk sugar which may be bought at the druggists as a food for infants. These various substances properly used form part of the food of man. In their natural condition in the milk they serve as the food of young animals. The chemist in his laboratory can tell the dairyman how much butter, cheese or milk sugar he can expect to obtain from a given lot of milk, and its consequent value. In a similar manner the components of rough foods, such as hay and grain, have been divided into groups which have different relative feeding values and the different relative proportions of which, determine in a large measure the feeding value of the food in which they occur as compared with other foods of a similar nature. The groups into which the numerous different substances, which make up a food are divided, are very similar in their nature to those into which the dairyman divides his milk. Their names and a brief description of each are given below.

Moisture.—All substances used as food for stock contain considerable proportions of water, even when apparently dry. The absolute amount varies with the condition of the weather, the nature of the food, the length of time after har-

vest, etc. In hay and grain it may vary from five to twenty pounds in every one-hundred, and even more; in fresh cut grass or other plants, from seventy to ninety pounds in every one-hundred. In some States, milk containing more than eighty-seven pounds of water in every hundred would be liable to be condemned as skimmed or watered. The water is determined in foods that the absolute amount of other matters may be known.

As used in connection with fodder analyses the term *dry matter* refers to water-free matter—matter which contains no moisture whatever. *Air-dry matter* refers to material which is as dry as it will become in ordinary air. Such matter will give off a considerable quantity of water when heated in a dry air. The moisture in such material is determined by keeping a definite quantity of the substance at the temperature of boiling water and passing through it a stream of dry hydrogen until it will lose no more weight. The loss in weight is the amount of moisture which the substance contained.

Ash.—This is the inorganic solid left when a plant is thoroughly burned. Many of the elements of which it is composed, are as essential to the life and growth of the animal as of the plant, but as nearly all foods contain an abundance of ash material as compared with other necessary nourishing matter, the ash is not generally taken into account in considering the food value of a substance.

Crude Fiber.—The woody matter which occurs in varying abundance in all plants falls in this group. It occurs in small quantities even in soft fruits and in grains, and its formation in vegetables gives them their "stringy" nature as they become old. The material classed under this name has generally some food value. In some instances more than half of it may be digested by the animal. Generally speaking, however, the greater its abundance the poorer will be

the food. It increases rapidly with the age of the plant as may be seen by comparing the results of analysis of pea vines shown in a table in the latter part of this bulletin.

Ether Extract is the material which will dissolve out of a food by continuously washing it with pure ether such as surgeons use to produce insensibility to pain. The nature of this extract depends upon the material being analyzed. From grains or seeds it is nearly pure fat or oil, while from grasses, pea vines, etc., it contains varying quantities of coloring matter and other impurities which lessen its food value. A small amount of fat in food is believed to aid digestion. It has been proved beyond doubt that the fat or oil in plants is not the only source from which animals derive the fat stored up in their body. The body is able to construct such fat from other material fed. On other grounds it is assumed that each pound of fat as it occurs in the food of animals has a nourishing value equal to two and two-tenth pounds of such matters as starch and sugars.

Crude Protein.—This name is given to a group of substances each of which contains nitrogen as one of the essential elements, thus distinguishing it from the substances of all the other groups. Many of the substances of this group are very similar to the white of eggs, the so-called albumen, and are therefore called *albuminoids*. Some of the substances of this group are found wherever living matter is found and through their agency the parts which make up the other groups of food matter are produced. As constituents of food they stand apart from those of all the other groups as is briefly explained under the head of *Nutritive Ratio*. Crude protein is still further subdivided into two smaller groups: The *true albuminoids* and the *amides*. Of these the latter is believed to have somewhat less food value than the former but their true relation is not definitely known and is probably variable. The nitrogen which the plant contains probably

occupies a position first in one of the sub-groups and then in the other. In certain experiments with peas, to be hereafter described, the proportion of amides was greatest in those parts apparently growing most rapidly: namely, in the young stems and in the young pea pods. The indications are that they were afterwards converted into the true albuminoids, thus appearing as a step in the construction of the latter. It is also probable that these amides were originally formed from other albuminoids which have been converted into this form that they might be transferred from one part of the plant to another.

Nitrogen Free Extract.—In the analysis of foods all matters not included under the proceeding divisions is classed as belonging to this group. It is therefore composed of a considerable number of different products, chief among which are sugar, starch and other substances which are more or less readily converted into sugar during the process of digestion. In that form they are carried by the blood to various parts of the animal body and used for its nourishment.

The *digestible portions* of food are those which are absorbed from it in its passage through the stomach and intestines. Numerous experiments have been made to determine the proportions of the different ingredients of various foods which are thus absorbed. The average results for each food, of the most reliable of these experiments is taken as a basis upon which the digestible portions of other quantities of the same kind of food are estimated. To illustrate: In experiments made by the North Carolina Experiment Station* by feeding pea vine hay to a sheep and a goat the average amount of different groups of food matter digested from the hay were as follows: Of each 100 parts of crude protein, 64.5 parts; of fat, (ether extract) 50 parts; of crude fiber, 42.9 parts; of nitrogen free extract, 70.7 parts; and of the

*Technical Bulletin No. 4, November, 1892, p. 11.

entire dry matter, 59.2 parts in every 100. From these results and the analyses of the different samples of pea vine hay compared in the latter part of this bulletin their nutritive ratios are computed.

Nutritive Ratio.—It has been found that when those parts of the crude protein which are digested from a food hold in quantity a certain relation or ratio to the quantity of other digestible matter in the food, ash not included, better results are obtained from a given quantity of that food than when the relative proportion of such crude protein is either greater or less. Considering the digestible protein as one part the simple ratio which shows the corresponding number of parts of other digestible matter is called the *Nutritive Ratio.* When a given food contains the different ingredients in other than the desired proportion it may be mixed with other foods having a higher or lower ratio in such proportions as may be required to give the desired results. There is not space enough here to explain numerous problems which arise in this connection. Persons desiring to become acquainted with them may do so by consulting Armesby's Manual of Cattle Feeding.

The above described groups of food matter may be compared to the different parts of milk as follows: The moisture corresponds to the water of milk; ether extract to the butter fat; crude protein to casein and other matters which form the curd of sour milk; nitrogen free extract to the milk sugar; ash to the various salts always dissolved in milk and which will be left as an ash upon evaporating it to dryness and burning. Crude fiber is peculiarly a plant product—the woody framework of the plant. Those portions of it which are digested by the animal are converted into sugar in the same manner as starch and much other of the nitrogen free extract.

The solid matter of milk is for the most part digestible.

The average nutritive ratio of cows milk is about one part protein to four parts of other digestible matter, or expressed in the form of a ratio, 1 : 4.

Analysis of Some Different Grades of Hay from the Memphis Market.

Though the analyses of stock foods have for many purposes proved of much value, among the coarse fodders such as hay, the amount of nutritive matter which they will be shown to contain upon analysis, frequently has little connection with the price which the article will bring in the markets. Below are given the results of analysis of several different grades of hay obtained from the Memphis market together with the quoted selling price of those grades at the time the samples were obtained.

It will be noticed that "choice timothy hay," though one grade higher than "No. 1 timothy," contains both less fat and less albuminoids, or protein, and would consequently be classed as less nutritious. The latter was said not to grade choice because of its having a brown leaf. So, too, Arkansas prairie does not appear by analysis to be much inferior to choice timothy, and yet, those who have had experience in feeding the two have no question as to its inferiority. Horses eat it with less relish probably because of its harsh nature and of a disagreeable flavor which is indicated by its odor. Its nutrients may also be less digestible. Clover hay while acknowledged by many to be a stronger feed than timothy, has its objections as a feed for horses which lessens its demand. The sample of pea vine hay (or more properly straw, for the peas had been removed) was analyzed because of its stemmy nature and freeness from leaves. When the leaves are not removed it shows a much better analysis. It is said to be much sought after in Memphis as a food for cattle, but its price was not ascertained.

Hay from Memphis.— Table of Analysis.

	Arkansas Prairie.	Choice Timothy.	Timothy No. 1.	Clover.	Pea Vine.
Moisture	11.20	10.35	10.80	12.25	9.55
Ash	6.80	5.80	6.05	7.90	6.15
Crude protein	5.34	6.48	7.69	9.69	8.75
Ether extract	2.23	2.27	2.57	2.60	1.55
Crude fiber	29.97	30.05	30.25	29.60	29.20
Nitrogen, free extract	44 46	45.04	42.64	39.96	44.80
	100.00	100.00	100.00	100.00	100.00
True albuminoids	5.06	5.62	6.81	8.42	6.31
Amides	.28	.86	.88	1.27	2.44
Market price per ton	$6.50	$13.00		$12.50	

The figures indicate the number of pounds in each one hundred.

For the benefit of those who may desire to become acquainted with the points upon which different qualities of hay are classified in the city markets and thus produce an article suitable to command the highest market price, the rules adopted by the Memphis Merchants' Exchange for the use of inspectors in grading hay are given below, followed also by the average quoted price of each grade, for the months named, as taken from the Weekly Price Quotations of Shanks, Phillips & Co., Memphis, Tenn., to whom I am indebted for the above named samples of hay and information bearing on this point.

Choice Timothy Hay.—Shall be pure timothy, sound, bright color and well cured.

No. 1.—Shall be timothy, and not more than one-fifth of other tame grasses (excepting clover) mixed, good color, well cured and free from must.

No. 2.—Shall be timothy, and not more than one-third of other tame grasses (excepting clover) mixed, well cured and free from must.

Mixed Hay.—Shall consist of tame grasses (excepting clover) mixed, not enough timothy for No. 2, well cured and free from must.

Choice Clover Mixed Hay.—Shall be timothy hay, sound, with a bright color, and shall contain not more than one-eighth clover.

No. 1 Clover Mixed Hay.—Shall consist of timothy and not more than one-fifth clover mixed, good color, well cured and free from must.

No. 2 Clover Mixed Hay.—Shall consist of timothy and not more than one-third clover mixed, well cured and free from must.

Choice Prairie Hay.—Shall be upland prairie hay, bright color, sound and well cured.

No. 1 Prairie Hay.—Shall be upland and midland prairie hay, bright color, sound and well cured.

No. 2 Prairie Hay.—Shall be upland or midland and swale or slough hay mixed, well cured, good color and free from must, or stained upland and midland hay, sound and free from must.

All damp, musty or otherwise unsound hay shall grade "No Grade."

Wholesale Prices of Different Grades of Hay in Memphis.

Fancy timothy hay	per ton,	$13.50
Choice timothy hay	" "	13.00
No. 2 timothy hay	" "	11.50
Choice Kansas prairie hay	" "	9.00
Choice Arkansas prairie hay	" "	6.50
German millet,	per 100 pounds,	0.65

Average for January and February, 1893.

Effect on Corn of the Different Methods of Securing Fodder.

In the fall of 1892 an effort was made to obtain some information as to the possible loss of corn which may occur by the different methods of securing a part of the stalks for fodder. An exact acre of late corn was secured and each of every fourth hill throughout the area was treated in one of the following four ways:

1.	Left in natural condition.	1	3	1	3	1
2.	Stalk cut and shocked.	2	4	2	4	2
3.	Leaves stripped.	3	1	3	1	3
4.	Topped above ear.	2	4	2	4	2

The arrangement adopted is shown in the diagram and is such as would hardly fail to correct any irregularities in soil. The effects of light and shade would hardly be great but to correct it as far as possible 1 and 3 alternate their positions with reference to the cut hills.

The bottom leaves were dying and the corn was denting and nearly past milk. It was possibly slightly green but could not be left longer without much danger of loss of fodder. There is not greater loss of grain from pulling the fodder than in two years of quite similar experiments at the Georgia Station.*

In the following table are given the number of pounds per acre of thoroughly air-dryed and cleaned shelled corn, the loss in pounds by each method of harvesting, and the total number of bushels of fifty-six pounds each produced:

Method of Treatment.	Pounds per Acre.	Pounds Loss per Acre.	Bushels per Acre.
Left natural	1241		22 1-7
Topped above ear	1224	17	21 5-7
Leaves stripped	1102	138	19 5-7
Stalks cut and shocked	1075	166	19 1-5

The nitrogen was determined in the different lots of shelled corn and is shown below as the per cent in the thoroughly dry or water-free matter. The higher per cent in the stripped and cut lots is a characteristic of immature development.

	Stalk Natural.	Stalk Topped.	Leaves Pulled.	Stalk Cut.
Per cent total nitrogen	1.76	1.81	1.87	1.87
Per cent albuminoid nit	1.76	1.79	1.82	1.80

*Georgia Bulletins Nos. 10 and 15.

In the table of fodders which follows the weights per acre have been so computed that each fodder contains eleven per cent of water. In harvesting the ears were "slip-shucked" in the usual way and the weight of husks given is based on the average of the four lots. All the fodder was fed to a horse. Each feed of the full stalks was weighed as were also the butts left uneaten. The average amount left was 16.5 per cent and it would have been less if the stalks had been fed more sparingly. It sometimes contained a few leaves. The weight given is based upon this per cent. Practically none of the tops were left uneaten.

The high feeding value of the pulled fodder is indicated by its analysis. The proportion of both ether extract and protein is more than in the tops and the ether extract is more than twice as great as in the cut fodder while the crude fiber is very low. The portion of the cut fodder uneaten contains a half more ether extract and nearly the same amount of protein as the husks but a much higher proportion of fiber. The tops contain more protein, more ether extract and less fiber than the cut fodder.

Weight per Acre and Composition of Corn Fodders.

	Leaves.	Tops.	Whole Fodder.	Uneaten Butts.	Husks.
Pounds per acre each with 11 per cent moisture	443	438	1776	295	236
Composition of Dry Matter.					
Ash	10.76	8.39	7.57	4.68	3.34
Crude protein	10.97	7.77	6.35	3.40	3.18
Ether extract	2.80	1.83	1.32	1.02	.70
Crude fiber	20.77	26.20	33.05	40.32	33.57
Nitrogen, free extract	54.70	55.81	51.71	50 58	59.21
Total nitrogen	1.76	1.24	1.02	.54	.51
Albuminoid nitrogen	1.58	1.05	.92	.42	.49
Amide nitrogen	.18	.19	.10	.12	.02

SUMMARY.

There was considerable decrease in the yield of the grain of corn both by pulling the leaves and by cutting the entire stalk but a greater decrease by the latter method.

In topping the corn there was but little loss of grain and a quantity of fodder equal to that from the stripped portion was obtained though it was of poorer quality. It was however more easily harvested and as the leaves of the plant begin dying at the bottom it can be left until the corn is nearer ripe without material injury.

Changes in the Composition and Yield per Acre of the Cowpea, During the Period from Flowering to Maturity.

In the summer of 1891, a series of work was begun for the purpose of studying the Cowpea *(Vigna Sinensis)* at different stages of its development. The plan of the experiment was to cut the peas at different dates separated by six days each and extending from the time the peas began flowering till they were ripe, noting the total weight of each harvest, and determining the composition of the different parts, including the nitrogen in the roots.

Whippoorwill peas were sown June 13th with a common wheat drill, making rows about nine inches apart. When the young plants were about three inches high, they were thinned to three inches in the row. This is nearly equivalent to the sowing broadcast of five and one-half pecks of seed per acre. After hoeing at this time they remained nearly free from weeds and grass throughout the summer.

Seven cuttings were made, the first being August 7th, the last, September 14th. At each cutting three plots of one one-thousandth acre each were taken, one from each end and the other from the center of the area selected. The shape of the plot was a rectangle, 3x14½ feet, and it was so taken that the drill rows run across the short direction, thus

correcting as far as possible the irregularities at the edge. In the weights given, those of the last two cuttings are each the average of two plots only because of great irregularity in the growth of the third, noted at the time of cutting. After carefully air-drying in the laboratory the peas were separated from the straw and each part analyzed separately.

At the time of the last cutting, another plot containing three one-thousandths of an acre was cut, separated into four parts, stems, leaves, pods and peas, and each part analyzed separately. These peas had been thinned to nine inches in the drill row. They matured somewhat quicker than those thinned to three inches and were over ripe when gathered, so that a larger proportion of the leaves had fallen. The vines also seemed to run somewhat less than those left thicker.

At the time of each cutting, roots were taken from each plot to a depth of three feet. The area used for the purpose was exactly two feet square. The soil is somewhat heavy sandy loam with sandstone subsoil. The earth was washed from the roots upon a sieve immersed in water, and all foreign organic matter occurring in the soil was removed as thoroughly as possible. Though this did not give entirely satisfactory results, it is believed that the data thus obtained are comparable and not without value.

In the nature of its growth the cowpea is greatly influenced by soil, thickness of planting, seasons and other conditions not known. It differs from the grain crops in that the time of blossoming and consequent production of fruit extends over several weeks. At no period except when completely ripe, will the peas be all at the same stage of maturity. So, too, the large leaves drop rapidly during the latter period of growth, which influences greatly the weight and composition of the straw. Notwithstanding that great care was taken to secure a growth which should be uniform

for all the plots, the growth was not entirely uniform, and it is probable that the difference in time between the different cuttings does not always indicate a corresponding difference in the maturity of the plants. For these and other reasons the data set forth in the tables which follow, marking the conditions of the different cuttings, can be considered only as indicating the general principles or laws which govern the relative increase and decrease of the different groups of food matters. They cannot be considered as accurately indicating the rapidity of the change, or, assuming that they could, such rate would not agree with that of other conditions of growth. Where comparable, however, with common experience and with data obtained from experiments on other plants, the results obtained agree so closely as to the nature of the changes as to warrant their use as illustrations and as a basis for drawing of such new conclusions as may be indicated.

In Table A are shown the dates of cutting; the number of pounds of water in each one-hundred parts of green matter harvested; the total weight of cured hay, and the number of pounds of peas in each one-hundred of hay.

Table A.

No. of Cuttings.	*Dates of Cuttings.	Per Cent Water in Green Matter.	Pounds Total Dry Matter Harvested.	Per Cent of Hulled Peas in the Dry Hay.
1	August 7th	83.4	1567	Blossoms.
2	" 14th	82.1	1874	.....
3	" 20th	84.0	2118	4.6
4	" 26th	81.8	2525	9.9
5	September 2d	78.3	2688	25.2
6	" 8th	75.1	2747	27.0
7	" 14th	68.8	2403	37.0

*The condition of the weather throughout the period of growth is shown in Table for 1891 at end of this Bulletin.

Composition of the Dry Matter.

Composition of the Dry Matter.—In Table B is shown the number of pounds of the different ingredients in each one-hundred pounds of the straw. For comparison with them-

selves and other analyses the results are computed on matter free from moisture. The composition of the peas and of the different parts of the plants on the large plot are shown in like manner in Table C.

In the straw the ash and crude protein decrease steadily from beginning to end. The ether extract increases to the fourth and fifth cuttings then decreases. The crude fiber shows, with slight exception, a continuous increase. The nitrogen free extract diminishes to the third cutting then rapidly increases. The falling off noted in this ingredient is somewhat exceptional but is accompanied by a corresponding increase of crude fiber which in its chemical nature is quite similar. Since the crude protein is estimated by multiplying the total nitrogen by 6¼ the total nitrogen found shows a decrease directly proportional to that of the protein. The amounts of phosphoric acid and potash in the straw are quite irregular.

In the peas the crude protein differs little in the last three cuttings but is higher in the first two which produced them; the ash gradually decreases. The ether extract shows a continuous and marked increase till maturity, as is for the most part the case with the nitrogen free extract. The per cent of crude fiber shows a gradual decrease; in this respect it differs from the results shown in most other series of analyses of ripening plants. This exception is probably due to the fact that the fiber occurs mainly in the skin of the pea which is less in proportion to the total weight as the pea increases in size. The phosphoric acid is practically the same in the last three cuttings, but the potash shows a continuous decrease in per cent from beginning to end.

In the parts of the plants from the large plot the differences in the per cents of the different ingredients are very marked. The high proportion of ash and especially ether extracts in the leaves are to be noted. There is also a large

proportion of crude protein in the leaves but less than in the peas, while the hulls and stems contain little protein and very large proportions of crude fiber. The nitrogen free extract is most abundant in the peas. The potash is most abundant in the stems but neither the hulls or stems contain much phosphoric acid.

Table B.

COMPOSITION OF DRY MATTER OF COWPEA VINES—PARTS IN EACH ONE HUNDRED.

Number of Cutting.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Ash	12.05	11.25	11.20	8.76	7.85	7.75	6.87
Crude protein	19.29	17.64	17.44	15.50	11.44	10.97	10.35
Ether extract	2.43	2.56	2.58	2.77	2.77	2.72	2.47
Crude fiber	24.93	29.15	31.36	31.13	33.84	33.90	34.14
Nitrogen, free extract	41.30	39.40	37.42	41.84	44.10	44.66	46.17
Total nitrogen	3.09	2.82	2.79	2.48	1.83	1.75	1.65
Albuminoid nitrogen	2.33	2.12	2.06	1.94	1.37	1.32	1.22
Phosphoric acid	.50	.42	.49	.33	.41	.32	.33
Potash	1.98	1.78	2.03	1.84	1.94	1.75	1.89

Table C.

COMPOSITION OF DRY MATTER OF COWPEAS AND PARTS OF COWPEA PLANTS.

	Peas cut at Different Dates.					Parts of Cowpea Plants.			
	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	Peas.	Hulls.	Stems.	Leaves
Ash	4.21	4.07	3.53	3.43	3.41	3.46	3.28	6.35	11.63
Crude protein	32.30	28.88	25.16	26.16	26.27	25.71	4.60	6.87	18.40
Ether extract	1.09	1.13	1.25	1.31	1.48	1.45	.51	.98	7.85
Crude fiber	6.78	6.22	5.77	5.49	5.38	5.34	46.51	43.13	16.00
Nitrogen, free extract	55.62	59.70	63.29	63.61	63.46	64.04	45.10	42.67	46.12
Total nitrogen	5.17	4.62	4.18	4.18	4.20	4.11	.73	1.10	2.94
Albuminoid nitrogen	4.45	4.19	3.93	3.88	3.99	3.92	.73	.80	2.28
Phosphoric acid	1.30	1.13	.91	.91	.93	.74	.15	.16	.40
Potash	2.12	1.96	1.67	1.61	1.52	1.52	.87	1.77	1.16

Weights per Acre at the Different Cuttings.

For the purpose of comparing the weights per acre, the results were all computed in such a manner that each one-hundred parts of straw should contain eleven parts of water and each one-hundred of peas, twelve parts, these being the

average amounts found upon analysis. The parts of the large plot are also computed to contain twelve parts water. The results for the parts separately are shown in Tables D and E, and for the complete hay in Table F.

In the straw the total weight was greatest in the fourth cutting, and there is a very marked falling off in the seventh. The same is true of most of the ingredients, though the ash and amides were greatest in the third cutting. The falling off in ash and in protein is more rapid than the falling off in total dry matter, which is a point of significance.

In the peas the total weight per acre increases throughout, as does all the leading food groups including fiber, the per cent of which latter diminished as the peas matured. The amides are slightly irregular.

In the total matter in peas and straw, the greatest weight was in the sixth cutting. There is a falling off in the seventh cutting in total weight and in all parts. As in the straw, the ash and amides are highest in the third cutting, and the protein and ether extract in the fourth, though the falling off to the next is not great. The large and continuous increase of nitrogen free extract and the corresponding increase of fiber up to the sixth cutting are to be noted.

Table D.

POUNDS OF FOOD MATTERS PER ACRE IN *AIR-DRY COWPEA VINES.

Number of Cutting.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Water	193.7	231.6	249.7	281.0	248.4	247.8	190.1
Ash	188.9	210.8	226.3	199.3	157.8	155.4	105.7
Crude protein	302.3	330.6	352.3	352.5	229.9	220.0	159.2
Ether extract	338.1	48.0	52.1	62.8	56.7	54.5	38.0
Crude fiber	390.7	546.4	633.6	707.9	680.1	679.8	525.0
Nitrogen, free extract	647.3	738.6	756.0	951.5	886.2	895.5	710.0
Total vines	1761.0	2106.0	2270.0	2555.0	2258.0	2253.0	1728.0
True albuminoids	227.9	248.7	260.1	276.0	172.1	165.4	117.7
Amides	74.4	81.9	92.2	76.5	57.8	54.6	41.5

*These results have been so computed that each lot of vines contains eleven pounds of water in each one hundred pounds of vines—this being the average found. The term *air-dry* indicates that the material is as dry as it will ordinarily become in the open air.

Table E.

POUNDS OF FOOD MATTERS PER ACRE IN AIR-DRY PEAS AND PARTS OF COWPEA PLANTS.

	Peas cut at Different Dates.					Parts of Cowpea Plants.			
	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	Peas.	Hulls.	Stems.	Leaves
Water	13 3	34.1	92.5	101.2	117.9	81.6	30.2	59.7	11.6
Ash	4.1	10.2	24 0	25.5	29.5	20.7	7-3	27.8	9-9
Crude protein	31.6	72.3	177.5	194.2	227.1	153.9	10.2	30.0	15.6
Ether extract	1.1	2.8	8.5	9.7	12.8	8.7	1.1	4.3	6.7
Crude fiber	6 6	15.6	39.1	40.7	46.5	32.0	102.9	188.8	13.6
Nitrogen, free extract	54.3	149.4	429.4	472.2	548.6	383.2	99.8	186.8	39.2
Total per acre	111.0	284.4	771.0	843.5	982.4	680.0	251.5	497.4	96.6
True albuminoids	27.2	65.6	166.9	180.0	215.6	146.6	10.2	21.9	18.1
Amides	4.4	6.7	10.4	14.2	11.5	7-3	.....	8.1	3-5

Computed to 12 per cent moisture; the average found in the peas.

Table F.

TOTAL AIR-DRY MATTER PER ACRE, VINES AND PEAS.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	*Large Plot.
Water	193.7	231.6	263.0	315.2	340.9	349.0	308.0	183.0
Ash	188.9	210.8	230.4	209.5	181.7	180.8	135.1	65.7
Crude protein	302.3	330.6	382.9	424.7	407.4	414.2	386.3	209.7
Ether extract	38.1	48 0	53.2	65.7	65.2	64.3	50.8	20.8
Crude fiber	390.7	546.4	640.2	723.5	719 2	720.5	571.6	337.3
Nitrogen, free extract	647.3	738.6	810.3	1100.9	1315.6	1367.7	1258.6	709.0
Total harvest	1761.0	2106.0	2381.0	2839.4	3029.0	3096.5	2710.4	1525.5
Albuminoids	227.9	248.7	287.3	341.3	339.0	345.4	333.3	190.8
Amides	74.4	81.9	96.6	83.4	68.4	68.8	53.0	18.9

*Peas on this plot were one-third as thick in row as on the other plots.

Nutritive Ratio of Pea Hay.

The relative feeding values of the same weights of produce at the different cuttings may be roughly expressed by means of the nutritive ratio. The proportion of digestible matter is based upon the results of experiments made at the North Carolina Experiment Station upon cowpea hay, cut when the peas were well formed but not ripened. Though not strictly applicable to all the conditions where used they are the most reliable data obtainable. In the straw the proportion of protein in the first cutting is more than twice what

it is in the last, while in the hay or whole produce the proportion of protein does not diminish nearly so rapidly because of the large amount in the peas.

Nutritive Ratio of Pea Straw and Pea Hay.

No. of Cutting	1	2	3	4	5	6	7
Straw	3.4	3.8	3.8	4.6	6.6	6.9	7.5
Hay	3.4	3.8	3.7	4.2	5.0	5.0	4.8

The figures in the table show the number of parts of other digestible food matters (ash not included) to one of protein.

Cowpea hay at the time of the greatest yield, which is when the majority of the pods are formed but not ripe, gives a good strong food suitable for milch cows and working animals, as may be seen by the nutritive ratios of the fifth and sixth cuttings.

According to the best data at hand the ingredients of the peas are much more digestible than the corresponding ones of the straw. The nutritive ratio of the fully ripened pea is about 1:3. It thus has a proportion of digestible protein three times as great as Indian corn, the nutritive ratio of which is about 1:9. It is highly probable that the two may be ground together and fed with better results than would be obtained by feeding either alone.

Some Further Data Upon the Growth of the Cowpea.

The results from the collecting of the roots in the foregoing experiment being unsatisfactory the following series of work was begun with the hope of obtaining more accurate and minute information concerning the growth of the pea plants and especially the roots.

A pit was dug in the ground four feet deep. The bottom was clay, so hard that it was necessary to remove it with a pick. A four inch tile drain was laid in the bottom of the pit. Thirty boxes were made by sawing twelve inch boards into lengths of four feet each, and nailing together so as to

give a soil area when filled of 10 x 12 inches. They were left open at both ends and set upright in the pit in three rows of ten boxes each. Dirt was then filled around the outside and a thin layer of clay tamped into the bottom of each. Each was then filled with the mixed and sifted surface soil of the surrounding land which was a clay loam. No better soil for the purpose was at hand. The soil was well rammed during the filling and an effort was made to fill all alike. After being settled by a rainfall they were refilled and the soil then settled but little more during the summer. The soil was planted with whippoorwill peas, July 6, 1892, and three plants allowed to grow in each box. The soil about the boxes was free from vegetation.

A short row of three boxes was taken up on each day of harvesting. The second series of boxes was not taken up but was moved beside those remaining after each gathering. For the first three dates the soil was washed from the roots as in the field during the previous year. This being again unsatisfactory, only the roots large enough to be picked from the soil with forceps and fingers were taken from the remaining boxes. The falling material was collected through the summer and weighed for each box separately. Those of each series were then mixed and the nitrogen determined.

While the material harvested was still green it was separated into parts, and the parts for each series of boxes were mixed, dried and prepared for analysis. All possible care was taken to check the work throughout. The results obtained are embodied in a series of tables and their explanations, which follow.

The weights in the tables having no further purpose than for comparison with one another are given as obtained, in grams. The basis taken for comparison is one box, the average of the three taken at each date. The weights given in all tables except that for the entire plant are of the dry

(water-free) matter and total nitrogen only. In the last two columns of each of these tables are given the number of parts of the total and of the albuminoid nitrogen in each one-hundred parts of the dry matter. In the table for the entire plants the weights of the albuminoid and the amide nitrogen are substituted for these per cents.

The plants of the ninth cutting were in the end boxes and made a more vigorous growth than did the others, and the results cannot in many respects be compared with those from the others. In all the other series the plants of the inside box made less growth than those of the two outside boxes, but that does not destroy the accuracy of the comparison. The following points are shown in the tables as the results of the experiment, attention having already been called to the exceptional growth of the plants of the last cutting they will, for the most part, be ignored throughout the discussion.

THE RESULTS.

There is a decrease in the per cent of nitrogen from beginning to end in all parts except the fallen material. In this the nitrogen content is irregular for the different series but it does not differ greatly. The greatest total weight of the nitrogen in the leaves was at the time of the third cutting, and the diminution is more rapid than that of the total dry matter, which was also great from this time on. This diminution is not entirely due to the falling of the leaves as is apparant when the leaves and fallen matter are taken together. The latter was collected too soon after falling to admit of much decay.

With the exception of the fifth cutting the weight of dry matter in the stem increases slightly to the end, but the weight of the nitrogen in them decreases from the fourth cutting.

With the peas and pods together there is an increase in

the weight of both nitrogen and total dry matter and a more rapid increase in the peas alone. The younger pods necessarily contained many small peas.

There is an increase in the weight of the *fallen matter* from cutting to cutting as well as in the weight of the total nitrogen contained in it. This is also true in the main, in the per cent of the fallen in the total dry matter produced above ground up to the time of each cutting. The per cent is much higher in the last cutting—a fact which is apparently not dependent upon the excessive growth of the plants. The exception at the time of the sixth cutting may be explained by a drouth which occurred at that time.

The method of taking *roots* did not secure the finer freshly formed rootlets. In those parts secured there is a marked and steady decrease in both total dry matter and total nitrogen after the fifth cutting. This decrease is too regular to be considered purely accidental. It is also strictly in accordance with the diminution in dry matter and nitrogen found in the leaves and in the total nitrogen found in the stems, and is in agreement with the indications from the roots taken in the field experiment of the preceding year. It is also in accordance with what common observation teaches us occurs in the fleshy roots of such plants as beets and turnips when they put forth stalks and produce seed. It is possible that a portion of this matter may be used for the formation of young rootlets. Admitting that, there is still indication that a portion of the nitrogen stored up in the roots during the early stages of plant growth is transferred above ground for use during seed formation. That such transfer takes place from the leaves and stems and later from the pods to the peas is clearly shown.

When considering the weight of the *total dry matter* produced up to the time of each cutting, including the fallen matter and roots, a continuous increase is found throughout

except for a slight falling off in the eighth cutting. The same is true of the total and the albuminoid nitrogen.

The total weight of the *amide nitrogen* was greatest at the time of the fifth cutting, and there is a decrease on from there to the eighth cutting. In the field experiment the greatest weight of amides and consequently of amide nitrogen was shown to occur in the third cutting, which corresponds in the stage of development of the plant with the fifth cutting in the box experiments, namely, the beginning of the formation of peas. The proportion of amide nitrogen to total nitrogen varies throughout the growth of the plant but is greatest in the young stems and leaf stems in which the proportion diminished as the stems grew older. It is probably the form in which the albuminoids are transferred from one part of the plant to another. As the plants advance towards maturity the amides are converted into albuminoids which have a higher feeding value. There is consequently a gain from this fact as well as from the increase of total dry matter by leaving the plants to become more mature before cutting for hay.

TIME OF HARVESTING.

No.	*Date of Harvest.	Stage of Growth.
1	August 7	Vines beginning to run.
2	" 19	Vigorous growth. Many runners.
3	September 1	Plants beginning to bloom.
4	" 14	Some well formed pods.
5	" 26	Some peas large enough to separate from pods.
6	October 3	Nearly all plants ceased blooming.
7	" 10	Many pods ripened.
8	" 17	Several pods still green.
9	" 25	Pods nearly all ripened. Some vines growing vigorously. One dead.

* The date of planting was July 6, 1892.

LEAVES, INCLUDING LEAF STEMS.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
1	7.863	.440	5.60	4.71
2	15.905	.784	4.91	3.68
3	40.679	1.644	4.04	2.89
4	44.960	1.681	3.74	2.96
5	33.681	1.034	3.07	2.48
6	24.620	.670	2.72	2.10
7	24.441	.594	2.43	2.06
8	21.023	.542	2.58	2.04
9	24.895	.715	2.87	2.30

LEAVES AND FALLEN MATTER.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Grams Albuminoid Nitrogen.	Grams Amide Nitrogen.
3	43.179	1.701	1.217	.484
4	54.510	1.894	1.479	.415
5	50.231	1.444	1.130	.314
6	46.830	1.178	.891	.287
7	46.811	1.132	.912	.230
8	44.413	1.096	.864	.232

STEMS INCLUDING FRUIT STEMS.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
1	2.707	.083	3.07	1.84
2	7.550	.215	2.91	1.57
3	24.178	.423	1.75	1.27
4	41.150	.687	1.67	1.23
5	46.626	.601	1.29	.77
6	39.340	.421	1.07	.72
7	40.543	.365	.90	.65
8	41.546	.399	.96	.69
9	44.294	.408	.92	.66

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HARVEST FROM ABOVE GROUND ON EACH DAY OF CUTTING.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
1	10.570	.523	4.95	3.97
2	23.455	.996	4.25	2 99
3	64.857	2.067	3.19	2.29
4	89.110	2.514	2.82	2.17
5	100.512	2.347	2.33	1.77
6	100.150	2.426	2.42	2.02
7	108.034	2.461	2.28	2.04
8	106.549	2.455	2.30	1.95
9	134.729	3.438	2.55	2.22

PODS AND ALL PEAS.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
4	3.000	.146	4.89	3.34
5	20.205	.712	3.52	2.90
6	36.190	1.335	3.69	3.37
7	44.050	1.502	3.50	3.35
8	43 980	1.514	3.44	3.11
9	65.540	2.315	3.53	3.25

PEAS LARGE ENOUGH TO SEPARATE FROM PODS.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
5	9.300	.455	4.90	4.40
6	24.660	1.158	4.69	4.44
7	31.720	1.390	4.38	4.13
8	32.140	1.400	4.35	4.04
9	50.810	2.181	4.19	3.95

ROOTS LARGE ENOUGH TO PICK FROM SOIL.

No.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
			Total.	Albuminoid.
1	*		2.49	2.27
2			2.31	1.76
3			2.21	1.91
4	13.68	.279	2.04	1.70
5	13.98	.249	1.78	1.48
6	12.42	.188	1.51	1.20
7	11.37	.162	1.43	1.14
8	10.80	.152	1.41	1.17
9	15.97	.266	1.67	1.30

*The first three weights are not comparable with the others because of a different method of obtaining the roots, and are therefore omitted. In themselves they show a gradual increase, as would be expected from the growth of the remainder of the plant.

FALLEN MATTER COLLECTED.

No.	Per Cent.	Grams Dry Matter.	Grams Total Nitrogen.	Per Cent Nitrogen in Dry Matter.	
				Total.	Albuminoid.
3	* 3.0	2.50	.057	2.27	1.63
4	19.4	9.51	.213	2.24	1.57
5	14.1	6.55	.410	2.48	1.78
6	18.1	22.21	.508	2.29	1.68
7	17.1	22.37	.538	2.40	1.78
8	17.6	23.39	.554	2.37	1.86
9	22.8	39.88	.886	2.22	1.77

*The figures in this column indicate the number of parts of dry matter fallen for each one hundred parts of dry matter produced above ground up to the date of the cutting.

*TOTAL DRY MATTER AND NITROGEN FROM EACH BOX.

No.	Grams Dry Matter.	Grams Nitrogen.		
		Total.	Albuminoid.	Amide.
1	14.770	.627	.515	.112
2	33.045	1.218	.870	.348
3	86.537	2.547	1.890	.657
4	112.300	3.006	2.318	.688
5	131.042	3.006	2.282	.724
6	134.780	3.122	2.544	.578
7	141.774	3.161	2.720	.431
8	140.739	3.161	2.644	.517
9	190.579	4.590	3.905	.685

*Average of three boxes taken up at each date of cutting, including all parts: Stems, leaves, peas and pods, fallen matter, and roots.

The Fertilizing Value of Cowpeas.

Aside from its value as a food for animals the cowpea, as a crop for renovating and improving soils, stands in the Southern States second to none other. It belongs to the class of plants known as *leguminous* plants, which are believed to stand apart from most others in the relation which they hold to the free nitrogen of the air, as has been pointed out in Bulletin No. 19 of this Station, page 24. The following briefly reviewed facts have also been pointed out in the same bulletin:

While the leguminous plants may take a part of their nitrogen from the free nitrogen of the air most other plants derive their entire supply from the combined nitrogen of the soil. It is for the most part accessible to them only when in the form of nitrates or of ammonia salts. Both of these are formed in the soil as the result of the decay of organic matter. Ammonia salts are quickly converted into nitrates which are readily soluble in water and which will with each rain be washed from the soil or to depths beyond the reach of plant roots unless means are taken to prevent.

Phosphoric acid and potash, the two other most valuable manure elements, are derived by all plants entirely from the soil. They exist there in combinations which are nearly or quite insoluble in water and are washed from the soil in very small quantities only. By the action of the roots of plants the insoluble compounds of these substances are broken up and they are appropriated by the plant. So far as known, the roots of plants have no power to hasten the transformation of the combined nitrogen of soils into nitrates, but when present they will take up a portion of the nitrates already formed. These facts lead to the following conclusion:

The financial relation which a farm crop sustains to the store of the more valuable fertilizing elements of a soil depends

upon the amount of combined nitrogen retained to that soil and upon the amount of phosporic acid and potash removed from it in the harvest.

In conformity with this principle the phosphoric acid and potash have been estimated in the vines and peas of the field experiment and the nitrogen in the vines, peas and roots. The results of these determinations in the vines and peas are shown in Table H, and of the total dry matter and nitrogen in the roots in Table G. These results are stated in pounds per acre.

The greatest weight of total nitrogen in the pea hay occurred at the time of the sixth cutting, in the pea alone at the time of the last cutting, and in the straw alone at the time of the third and fourth cutting. The greatest weights of both phosphoric acid and potash occur in the fifth cutting for the total harvest and in the last cutting for the peas. For the potash there is a marked falling off the last cutting in both the straw and the total harvest. No estimation is made of the amount of nitrogen which may have been carried to the soil in the fallen matter. In the box experiments it was for the latter cuttings more than one-fifth of what remained in the produce above ground at the time of harvest. There is no data at hand to show how much of the nitrogen in this matter may be immediately converted into nitrates and possibly taken up by the roots and used again by the same plant nor how much of it may be retained in the soil in humus to be made available for the use of future crops.

The results from the collecting of *roots* at the time of the different cuttings was too irregular in the field experiments to give definite conclusions. When taken however in connection with the box experiments it is apparent there is not only a decrease in the per cent of nitrogen in the dry matter of the roots but a decrease in the total nitrogen per acre during the last cuttings because of its removal to parts of the plants above ground.

Table G.

ROOTS AND STUBBLE FROM SOIL BEARING COWPEAS AT DIFFERENT STAGES OF GROWTH.

No. of Cutting.	1	2	3	4	5	6	7
*Average lbs. dry matter per acre	860	672	1074	1051	931	830	950
Per cent nitrogen in dry matter	1.53	1.43	1.43	1.35	1.23	1.18	1.08
Average lbs. nitrogen per acre	13.2	9.6	15.2	14.2	11.4	9.0	10.2

*Average of three determinations at each cutting except for last two, which are an average of two only. Soil taken two feet square on surface and three feet deep. The weights include a stubble of about three inches.

Table H.

Chief Fertilizing Ingredients in Peas at Different Stages of Growth.

POUNDS NITROGEN, PHOSPHORIC ACID AND POTASH PER ACRE

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
Nitrogen in vines	48.4	52.9	56.4	56.4	36.8	35.1	25.4
Nitrogen in peas	.....	.....	5.1	11.6	28.4	31.0	36.3
Total	**48.4**	**52.9**	**61.5**	**68.0**	**65.2**	**66.1**	**61.7**
Phosphoric acid in vines	7.9	7.8	10.0	7.4	8.1	6.3	5.0
Phosphoric acid in peas	.....	.....	1.3	2.8	6.2	6.6	8.0
Total	**7.9**	**7.8**	**11.3**	**10.2**	**14.3**	**12.9**	**13.0**
Potash in vines	31.0	33.5	41.1	41.9	39.1	34.9	29.0
Potash in peas	.....	.....	2.1	4.9	11.3	12.0	13.1
Total	**31.0**	**33.5**	**43.2**	**46.8**	**50.4**	**46.9**	**42.1**

In places where commercial fertilizers are extensively sold, prices are put upon nitrogen, phosphoric acid and potash depending upon the prices for which substances containing these materials can be purchased. These prices are considerably modified and reduced in this State because of the cheapness of cotton seed meal and some other substances. In accordance with these conditions the price adopted for these ingredients in the following computations is for each pound of nitrogen, 10 cents; of phosphoric acid, 5 cents; and of potash, 4 cents. This would make the total of

these elements in a ton of cotton seed meal of average composition amount to $18.25. If the price were more, the points which it is aimed to bring forth would be favored rather than the contrary.

Taking the nitrogen in the roots the average of the last three cuttings, which is ten pounds per acre, there were retained to the soil, in the stubble and roots, nitrogen worth $1 per acre. At the time of the sixth cutting which is that of the greatest weight of hay, there was removed from the soil in the total produce of one acre, thirteen pounds of phosphoric acid worth 65 cents, and forty-seven pounds of potash worth $1.88, a total of $2.53.

Upon their face these figures are not consistent with the well-known fact that the stubble of peas often produce a marked increase in the succeeding crop of another kind. It is to be remembered that the figures state the commercial and not the agricultural value of the elements. In other words they give the price required to pay for these substances in commercial fertilizers. In many soils poor in organic matters it is the nitrogen portion of the soil that is by far the most valuable, and on many such soils the organic matter has a beneficial effect which would not be brought about by applying the same amount of nitrogen in the form of mineral salts such as sulphate of ammonia and nitrate of soda.

If at the time of cutting above mentioned, the peas have been picked and the pods returned to the soil, there would have been removed from the soil, potash and phosphoric acid worth 83 cents, and there would have been retained to it in the straw and roots forty-five pounds of nitrogen worth $4.50 per acre. If left on the ground throughout the winter a considerable quantity of nitrogen will be converted into nitrates and lost,* but if prepared as hay and fed to cattle and the manure applied at the time of preparing the ground for cotton, as

* Compare Alabama Bulletin No. 14, April, 1890.

pointed out by Mr. Bennett in Bulletin No. 23 of this Station, the greater part of the nitrogen of the straw will be in the soil for the use of the growing crop. This fact is indicated by comparing the nature of growth on the two plots in the experiment referred to above: "The cotton on the manured plat grew slower at first than that on the other plat, but the growth was steady and it retained a green, vigorous color and continued to make stalk and fruit until frost. The pea vine and cotton seed plat's growth was rapid from the first and began an early and rapid fruitage, It did not remain green and continue growing throughout the summer, but matured its fruit early and then ceased growing." This lengthening of the period of growth is a characteristic effect of nitrogenous manures noted in many other instances. For the purpose in hand it is as safe a standard of judging as would be the final weight per acre. In this particular instance, owing to a very exceptional season, the amount of cotton harvested was slightly less on the manured than on the other plot, but the condition of growth when frost came was such as to warrant men of experience in cotton growing to believe that the yield would have been much greater in an average season for that climate. This occurred, too, after the material had served its entire purpose as food for an animal, which is entirely in accord with the well-known fact that neither the nitrogen, phosphoric acid or potash of a food are retained in any great quantity by the animal using it.

Another point in farm economy may be pointed out in connection with the foregoing results. It has to do with all crops in which there is an alternative as to the feeding of the produce to animals or the selling of it direct from the farm. In many instances however, the value of the contained fertilizing ingredients as compared with the selling price of the product is far less than with peas.

In each ton of hay taken at the sixth cutting there was

30.3 pounds of potash worth $1.21, 8.3 pounds phosphoric acid worth 42 cents and 42.7 pounds of nitrogen worth $4.27, making a total of $5.90 worth of fertilizing ingredients. A moderate price for pea hay is $12 per ton, which would make nearly 50 cents worth of fertilizing ingredients removed from the farm for every dollar's worth of hay sold. At a selling price of $15 per ton the value of these ingredients in each dollar's worth of hay sold would be 40 cents. The composition of the straw at that time is not greatly inferior to that of clover hay and assuming it to sell at $10 per ton the value of the fertilizing matter removed from the farm in each dollar's worth sold would be 46 cents. In each dollar's worth of peas selling at $1 per bushel there are manurial elements which it would cost more than 30 cents to purchase. This is a point which it may be profitable to bear in mind in connection with the above mentioned feeding experiment.

G. L. TELLER.

SUMMARY, WEATHER RECORD AT FAYETTEVILLE, ARK., MAY TO OCTOBER INCLUSIVE, 1891.

Days.	MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER			
	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day
	Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.		
1	73	53	.10	Cloudy.	85	61	.....	Cloudy.	86	55	.....	Fair.	88	67	.03	Fair.	87	66	.....	Clear.	84	71	.....	Fair.
2	83	56	.....	Fair.	84	71	.....	"	84	60	.....	"	80	66	.....	"	88	65	.65	Fair.	89	69	.....	Clear.
3	73	54	.91	Cloudy.	87	64	.32	"	90	59	.....	Clear.	78	59	.....	"	69	53	.....	Clear.	87	65	.....	Cloudy.
4	71	57	.31	Fair.	87	61	.....	"	89	64	.62	Cloudy.	81	55	.....	Clear.	72	42	.....	"	64	46	.22	Fair.
5	72	53	.....	Clear.	85	67	.....	"	82	63	.....	"	88	59	.....	"	77	45	.....	"	68	41	.....	Clear.
6	64	44	.....	"	80	62	.72	"	88	64	.....	Clear.	82	68	.19	Cloudy.	85	52	.....	"	67	36	.....	Fair.
7	71	36	.....	"	71	60	.60	"	88	65	.05	Cloudy.	91	70	.....	Fair.	86	55	.....	Pt.Cld'y	58	30	.....	Clear.
8	75	43	.....	"	76	58	.....	Fair.	74	59	.....	Fair.	91	68	.....	Clear.	71	61	.....	Cloudy.	67	32	.....	Fair.
9	79	51	.....	"	82	56	.....	Clear.	80	50	.....	Clear.	92	68	.....	"	74	58	.73	Fair.	56	41	.....	"
10	78	49	.28	Cloudy.	86	68	.....	Fair.	80	57	.....	"	89	67	.....	"	81	55	.....	"	71	32	.....	Clear.
11	59	43	.....	Fair.	89	65	.....	Cloudy.	79	66	.23	Cloudy.	91	63	.40	Cloudy.	84	58	.....	Clear.	72	38	.....	"
12	63	39	.....	Cloudy.	87	60	.....	Fair.	89	67	.....	Clear.	88	63	.....	Clear.	81	64	.15	Fair.	75	42	.....	"
13	71	48	.....	Fair.	86	64	.....	"	92	70	.....	"	87	62	.....	"	82	65	.....	"	61	49	.20	Cloudy.
14	77	42	.....	"	84	67	.09	"	92	69	.....	Cloudy.	91	66	.....	"	85	54	.....	Clear.	71	45	.....	Clear.
15	78	45	.....	"	88	68	.....	"	74	62	.26	"	90	68	.....	Fair.	90	60	.....	"	77	35	.....	"
16	81	48	.....	Cloudy.	80	63	.69	Cloudy.	83	61	.....	"	93	71	.....	"	89	62	.....	"	76	51	.....	"
17	69	57	.47	"	79	61	.....	Fair.	89	64	.....	Fair.	94	70	.....	Clear.	89	68	.....	Fair.	74	57	.16	Fair.
18	72	55	.70	"	73	58	.....	"	85	61	.....	Clear.	93	71	.....	Fair.	90	65	.....	Clear.	67	41	.....	Clear.
19	82	54	.....	Fair.	82	58	.94	Cloudy.	88	59	T	Fair.	83	65	.24	Cloudy.	88	58	.....	Fair.	67	33	.....	"
20	74	66	.....	Cloudy.	85	25	.....	Fair.	88	64	T	Cloudy.	96	73	.....	Fair.	90	57	.....	"	81	34	.....	"
21	79	66	.....	"	85	65	1.43	Cloudy.	90	69	.....	Pt.Cld'y	90	70	.17	"	94	59	.....	"	73	44	.....	Fair.
22	75	57	.....	"	84	58	.....	Fair.	93	67	.....	"	86	55	.02	Cloudy.	92	56	.....	Clear.	66	49	.....	Clear.
23	75	47	.....	Fair.	90	61	.....	Clear.	86	63	.57	"	67	48	.....	Clear.	91	58	.....	"	76	36	.....	"
24	78	59	.....	Cloudy.	90	68	.....	"	87	63	.....	"	76	40	.....	"	91	62	.....	Cloudy.	86	57	.....	"
25	79	58	.....	"	88	68	.....	Fair.	90	63	.40	"	86	54	.....	"	90	60	.....	"	88	58	.....	"
26	63	57	.18	"	92	62	.....	Clear.	83	63	.....	Clear.	85	54	.....	"	90	56	.....	Clear.	91	57	.....	"
27	70	47	.22	Clear.	91	65	.....	Fair.	77	63	.93	Cloudy.	85	62	.....	"	88	62	.....	Fair.	72	48	.....	"
28	74	42	.....	"	90	66	.28	"	82	64	.....	"	76	53	.....	Fair.	84	65	.02	Cloudy.	74	39	.....	"
29	81	46	.....	Fair.	81	65	.....	Cloudy.	87	67	1.07	"	82	53	.13	Cloudy.	79	52	.....	Clear.	76	48	.....	"
30	86	56	T	"	81	61	.....	Clear.	86	67	.....	"	82	63	.....	Clear	85	56	.....	Fair.	71	53	.....	Fair.
31	86	56	T	"					78	68	1.30	Fair.	85	55	.....	"					69	48	.....	Cloudy.
	74°.7	50°.9	3.17		84°.3	63° 2	5.07		85°.1	63°.1	5.43		86°.1	69°.1	1.18		81 °7	58°.3	1.55		73°.5	45°.4	0.58	

TABLE SHOWING CONDITION OF WEATHER DURING GROWTH OF PEAS IN BOXES.

SUMMARY, WEATHER RECORD AT FAYETTEVILLE, ARK., MAY TO OCTOBER INCLUSIVE, 1892.

Days.	MAY				JUNE				JULY				AUGUST				SEPTEMBER				OCTOBER			
	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day	Temperature		Rain in Inch's	Character of Day
	Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.			Max.	Min.		
1	82	62	.....	Fair.	63	51	1.57	Cloudy.	84	59	.....	Clear.	88	66	.....	Fair.	82	50	.....	Fair.	83	51	.....	Clear.
2	75	64	.....	Cloudy.	71	49	.....	Clear.	84	70	.....	Cloudy.	91	63	.....	"	77	56	.....	"	85	49	.....	"
3	85	56	.96	"	75	46	.....	Fair.	81	65	.74	"	92	65	.....	Clear.	83	57	.....	"	85	52	.....	"
4	83	63	.....	Fair.	79	56	.....	Clear.	78	52	.....	"	96	65	.....	"	71	62	.....	Cloudy.	82	52	.....	"
5	84	66	.....	Cloudy.	72	60	.30	Cloudy.	78	54	.....	Fair.	96	67	.....	"	76	59	.16	Fair.	82	47	.....	"
6	79	62	T	"	82	60	21.	Fair.	79	57	.....	"	97	68	.....	"	81	49	.....	Clear.	86	48	.....	"
7	69	59	.01	"	86	60	.....	Clear.	78	61	.....	Cloudy.	97	70	.....	"	84	53	.....	"	87	52	.....	"
8	70	54	.89	"	85	64	.....	"	77	64	.10	Fair.	94	69	.....	"	86	55	.....	"	74	43	.....	"
9	70	51	.41	"	87	65	.....	"	80	60	.....	"	.....	68	.....	"	89	62	.....	"	73	37	.....	"
10	60	42	.....	Fair.	90	62	.....	"	81	61	.11	Cloudy.	.....	70	.....	Fair.	85	65	.....	"	77	39	.....	"
11	66	42	.....	Clear.	90	61	.....	"	88	62	.....	Clear.	.....	71	2.35	Cloudy.	72	57	1.46	Cloudy.	78	54	.....	"
12	78	50	.....	Cloudy.	90	66	T	"	89	67	.39	Cloudy.	.....	70	.....	Clear.	61	52	.02	"	78	62	.....	Cloudy.
13	76	60	.51	"	91	71	.....	"	90	67	.....	Fair.	.....	69	.....	"	74	47	.....	Clear.	81	65	.....	Fair.
14	76	57	2.85	"	90	67	.....	"	89	70	.....	"	.....	67	1.60	Fair.	77	48	.....	"	70	60	.96	"
15	71	58	.95	Fair.	92	66	.....	"	93	71	.....	Clear.	.....	59	.....	Clear.	84	51	.....	Fair.	72	58	.....	"
16	79	58	.....	Cloudy.	90	68	.....	"	91	68	.51	"	86	58	.....	Fair.	85	55	.....	"	82	57	.....	Clear.
17	70	57	1.50	"	91	67	1.30	Fair.	86	67	.....	Cloudy.	88	63	.....	Clear.	84	55	.....	Clear.	79	65	.....	Fair.
18	69	55	.15	Fair.	83	65	.....	"	88	70	.....	Clear.	89	64	.04	Fair.	84	54	.....	"	71	51	.64	"
19	63	47	.51	Cloudy.	88	64	.....	"	92	72	.....	Cloudy.	91	65	.....	Clear.	84	56	.....	"	69	44	.20	"
20	64	45	.15	Fair.	90	66	.....	Clear.	94	70	.....	Clear.	92	66	.....	Cloudy.	85	54	.....	"	65	53	.07	Cloudy.
21	49	38	.17	"	89	67	.....	"	94	72	.....	"	89	65	.....	Fair.	85	59	.....	"	66	56	.77	"
22	63	37	.....	Clear.	89	69	.....	"	94	70	.....	"	88	64	.....	"	87	64	.....	"	64	53	.40	"
23	70	42	.....	"	85	69	.....	Cloudy.	92	68	.....	"	89	66	.....	Cloudy.	90	65	.....	Fair.	55	45	.04	"
24	79	47	.....	"	84	69	.17	Fair.	92	70	.....	"	85	69	.76	"	85	63	.....	Clear.	60	41	.13	Fair.
25	74	59	.17	Cloudy.	85	62	.....	"	92	68	.....	"	80	68	.....	"	92	66	.....	"	58	31	.....	Clear.
26	80	58	.....	Fair.	91	65	.....	"	93	67	T	Fair.	77	64	.....	"	82	65	.....	"	64	30	.....	Fair.
27	72	58	.27	"	79	64	.....	Clear.	90	70	.....	Clear.	82	66	.....	"	88	49	.....	"	64	31	.....	Clear.
28	82	60	.10	"	85	52	.....	"	91	71	.....	Fair.	87	64	.....	Fair.	87	62	.....	Fair.	80	45	.....	"
29	85	57	1.00	"	91	58	.....	Fair.	84	67	.....	"	87	66	.61	"	87	61	.16	"	64	39	.....	Fair.
30	84	58	.....	Cloudy.	78	61	1.80	"	89	65	.21	Cloudy.	72	57	.03	Clear.	85	58	.....	Clear.	67	41	.....	Cloudy.
31	78	60	1.47	"					87	66	.05	Fair.	78	47	.....	"					72	54	.78	"
	73°.7	54°.3	12.07		84°.7	62°.5	5.35		87°.0	65°.8	2.11			65°.1	5.39		82°.4	56°.8	1.80		73°.3	48°.5	3.99	

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Arkansas

Agricultural Experiment Station

SEVENTH ANNUAL REPORT

For the Year 1894.

Fayetteville, Ark.

Agricultural Experiment Station

AT THE

ARKANSAS INDUSTRIAL UNIVERSITY.

FAYETTEVILLE, ARKANSAS.

SEVENTH ANNUAL REPORT

FOR THE YEAR 1894.

NOVEMBER, 1894.

"DIPLOMA PRESS,"
ARKANSAS DEMOCRAT CO., LITTLE ROCK.
1894.

ARKANSAS INDUSTRIAL UNIVERSITY,

FAYETTEVILLE, ARK., NOV., 10, 1894.

To His Excellency, W. M. FISHBACK,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Seventh Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

J. L. BUCHANAN,

President.

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Agricultural Experiment Station.

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His Excellency, W. M. FISHBACK, *President.*

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J. T. STINSON.....Horticulturist.
C. L. NEWMAN.....Assistant Agriculturist at Camden.
GEO. B. IRBY.....Assistant Agriculturist at Newport.
J. F. MOORE.....Assistant Chemist and Librarian.

FINANCIAL REPORT.

AGRICULTURAL EXPERIMENT STATION

AT THE

ARKANSAS INDUSTRIAL UNIVERSITY.

In Account with the United States Appropriation.

1894. DR		
To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1894	$15,000.00	
To sales produce	1,105.10	$16,105.10

1894. CR.		
Salary	$8,649.90	
Labor	2,003.49	
Sundry Supplies	1,533.99	
Printing and Mailing	785.85	
Seeds and Trees	152.26	
Chemical Supplies	266.55	
Freight and Express	235.85	
Technical Apparatus	356.98	
Building	778.45	
Live Stock	70.35	
Library	176.75	
Feed	176.50	
Travel	374.28	
Miscellaneous Expenses	568.00	$16,129.20

The foregoing Statement is copied from the Experiment Station books which have been duly examined and found correct by the Auditing Committee of the Board of Trustees.

R. L. BENNETT,
Director.

Report of Director.

This report contains the completed work and the financial statement of the fiscal year ending June 30, 1894. Experiments and investigations have been continued in each division of the Station work upon questions of practical importance to farmers, fruit growers and stock raisers of the State.

The completed work of the year is contained in six Bulletins and a full text of each appears in the succeeding pages.

The Bulletins and their subject matter are as follows:

BULLETIN 25.—*Animal Pathology*—Unsound Corn and Forage as a Cause of Disease in Live Stock—Colics in Horses and Mules—Some Further Experiments with Texas Cattle Fever.

BULLETIN 26.—*Horticulture*—Spraying Apple Trees—Spraying for Apple Scab—Spraying for Bitter Rot—Prevalence in the State of Apple Scab and Bitter Rot—Varieties of Apples in the State Reported as Surest Bearers—Some Apples Adapted to all Sections of the State—Arkansas Seedling Apples.

BULLETIN 27.—*Agriculture*—Late Crops for Overflow Lands—Corn: Varieties for all Sections of the State; Corn Culture—Rotation of Crops—Cotton: Egyptian Varieties; Cotton Culture—Stack-Frame for Curing and Storing Cowpea Hay—Cowpea Hay—Forage Plants—Oats for Hay.

BULLETIN 28.—*Agriculture*—Rye for Green Winter Feeding—Fertilizer Experiments with Rye—Onions from Seed—Salsify or Oyster Plant—Fall Raised Irish Potatoes—Preparation of Soil for Cotton—Bermuda Grass—Pocket Gopher—Moles.

BULLETIN 29.—*Agriculture*—Wheat Experiments on Sandy Loam Soil—Some Grass Experiments on Clay Loam Soil.

BULLETIN 30.—*Stock Feeding*—Feeding Standards—Some Arkansas Stock Foods; Compounding Rations.

The most important permanent improvements made during the year were made on the Southern Sub-station at Camden, and the reader is referred to a report upon that Station, page 87 of this report, for information concerning it, and the chief lines of work to be pursued there.

The continued decline of the price of cotton, the chief product of the State, especially the extreme low price for which the present crop is selling, is causing a general inquiry among farmers for other crops that may be grown at a greater profit than cotton, and the Station is endeavoring by experiment and by correspondence to aid them in their inquiry. Through the Agricultural and Horticultural departments and especially the Southern Sub-station the Station hopes to be able to make such practical experiments and furnish information on lines of farming that will aid farmers in a profitable diversification of their crops. The lines of farming that may be done in the State and that offer the most profitable returns are: Fruits, small fruits, early and late vegetables, beef, pork and a few farm crops that are not now grown to any extent. All of these lines, where intelligently pursued in the State, are without a single exception yielding large profits to those engaged in them. While the price of cotton has not yet declined so low as to make its production impossible, it has made necessary for those who grow it to produce all the food supplies needed on the farm by both man and beast instead of buying them, as heretofore, from other States. And also those who wish to realize much profit from their labor and money are compelled to abandon cotton and engage in other lines of farming. In view of

Saprophytic organisms occurring on imperfectly cured or preserved grain, hay, or silage, are chiefly species of moulds, yeasts and bacteria. They render the food "musty."

The evidence connecting such damaged food with disease in animals is necessarily based more on general observation than on experimental research. The special forms of disease in the horse which have been attributed to the use of such food seem to be due to a local irritative action on the digestive organs (ptyalism, gastro-intestinal catarrh, nephritis, colics, etc.), and to a toxic action on the central nervous system, giving rise to paralysis and cerebral disturbance such as are found in this, so-called "Blind Staggers."

The comparatively few experimental tests which have been made of the action of such fungi when fed to horses have given contradictory results. N. S. Mayo,* during an investigation of Blind Staggers in Kansas in 1891 fed a colt with corn artificially infected with a mould, *Aspergillus Glaucus*, which occurred naturally on the field corn there. After ten days the colt died, and, although no symptoms are recorded, the dissection showed changes such as he had found in Blind Staggers occurring naturally. He concludes that Staggers is caused by feeding corn which has been attacked by this mould.

At Delaware Station† pure cultures of a mould, *Aspergillus Niger*, were fed in large quantities on different occasions to a horse without producing any evil effect.

Feeding tests of the same kind were made at this Station on several occasions. In the month of December, 1890, two cattle were fed for six weeks on unsound corn. The ears which were worst affected by worms, mould and smut, were picked out and fed twice daily. No bad effect was noticed.

*Kas. Agric. Exp. Sta. Bul., No. 24.

†Fourth Annual Report Del. Agric. Exp. Sta., 1891.

In January, 1892, a similar feeding test was made on a colt. Shelled corn, moistened and sprinkled with moulded corn from the field and crib was fed after becoming thoroughly moulded. Two weeks of this diet produced no disease.

On examining unsound ears of corn during two years, I have found that in this locality by far the most common fungus found thereon is the common green pencil mould, *Penicillium Glaucum*. This mould is found on almost all ears which have been attacked by the corn worm. Usually only the tips are affected, but the percentage of ears thus attacked is often very large. A comparatively small number of ears are found to be invaded throughout by another fungus which, when fruited, has a pink appearance, but the species was not determined. In these ears there was no apparent injury from worms and the husks were always closely adherent throughout their whole length. Species of *Mucor* were also occasionally seen and also bacterial growths in the grains which had been partly worm-eaten. Aspergillus glaucus or other species of Aspergillus was never found.

Corn which becomes moulded after picking and either before or after shelling seems also to be attacked almost exclusively by the common pencil mould.

That moulds may be fed to horses for a considerable time without producing disease seems to be shown by other feeding tests here.

In the winter of 1892 an old horse was fed for three weeks on shelled corn which, having been picked too early, had become badly infected with Penicillium. Every grain showed masses of spores of this fungus adhering to it. At the end of that time artificial cultures of the same mould on bran were substituted after full fruiting of the mould was established. It was fed daily for two weeks longer. The horse ate it readily and appeared to be unaffected. Another

colt four years old was fed for five weeks with pure cultures (grown on cooked potatoes) of Aspergillus niger along with bran and hay. In this case also the result was negative.

While the experimental proof of the injurious action of moulds is thus unsatisfactory, we have in veterinary literature (chiefly foreign), numerous records of disease in both horses and cattle in which the history plainly pointed to parasitic fungi (on plants) and moulds as the cause. The symptoms recorded in these cases are sufficiently like those of Blind Staggers to indicate a similarity in cause—namely, sudden attack of paralysis beginning in the hind quarters and extending forward, loss of power of swallowing, ending in spasms and delirium; but these symptoms vary evidently according to the character of the poison—that is, the species of fungus with which the food is affected. Outbreaks of disease of this kind are recorded as occurring both in cattle and horses from eating grain or fodder affected by rusts *(Puccinia graminis* and other species*)*, smut (species of *Ustilago* and *Tiletia)* and moulds of which are implicated chiefly Penicillium glaucum and species of Aspergillus and Mucor. The evidence pointing to the cause of the trouble is furnished by the history of such cases. Within a short time several animals are suddenly attacked by the disease and an examination of the food shows it to be invaded by one or more species of fungi. The substitution of sound food brings about a cessation of the disease.

It is on the same evidence that we connect this "Staggers" of horses with the feeding of unsound corn.

In order to obtain as much of such evidence as possible from those who have had actual experience with the disease this question as to the supposed cause of Blind Staggers was included in our annual circular sent to correspondents. Out of forty answers in which an opinion was expressed on the subject based on personal experience, twenty-three believed

that the disease was caused by damaged corn either on account of being worm eaten and mouldy or from corn which was raised on new ground. Four thought that it was caused by over-heating. One ascribes his losses to feeding corn without any roughness; one to feeding hard, flinty, Northern grown corn. Eleven, without being able to give any positive opinion as to its cause, state that unsound corn does not cause it. A few of these opinions on both sides of the question may be of interest:

Paul P. Davidson, Clark County.—"A few years ago I lost five head of work horses and a great many of my neighbors lost horses all from Blind Staggers. The same year I and my neighbors had a great deal of damaged corn as it was a very wet fall and corn damaged badly."

R. G. Conn, Independence County.—"Some years ago horses died here to an alarming extent with Blind Staggers. This happened most generally when new ground corn was fed. My losses with this disease are invariably when I feed such corn."

E. A. Nichols, Garland County.—"The disease prevails here only in years when overflows come and corn crop is mouldy."

J. P. Poe, Columbia County.—"Last year was the wettest year known in the history of this county. The result was we had a large amount of mouldy, rotten and blasted corn. We were forced to use this corn largely in making this present crop. I am quite old but never heard of so many horses dying with Staggers as died last spring while this blasted corn was fed. As soon as this corn gave out and we began to use oats and grass pastures we ceased to have Staggers. The farmer that sorted his corn, shelling off every rotten or damaged grain, lost no horses, but the farmer that trusted the feeding to the boy who fed without sorting his corn is the man that lost his horses. The horses that were out on

the range had no Staggers while those that were fed on the damaged corn died with Staggers."

S. A. Martin, Crittenden County.—"There was more frosted corn in this county last season than usual and less Blind Staggers."

W. B. Fountain, Cross County.—"I had one horse to die with Blind Staggers and he never had any corn. He was on the range."

W. A. Isrig, Perry County.—"On the contrary, on account of the corn crop being late (caused by overflow), there was more mouldy corn fed than I ever knew of before, yet we have been remarkably free from this disease this year."

L. C. Balch, Pulaski County.—"I lost two horses and have another sick now. They had not been fed on grain of any sort for some months—were fed on grass. I have no doubt it was stagnant water in the bayou to which they had access. Since moving them from this water, which was very bad, with a greenish scum on it, none have been attacked. Several head of horses died last year in this vicinity—cerebro-spinal meningitis we call it. Those that died last year had access to bad water; no other known cause."

From the correspondence of which the above is a sample, it is evident that Staggers in horses occurs most frequently, in this State, when damaged corn is fed but that it also occurs in horses which have not been fed on grain of any kind and that in some cases bad corn has been fed quite extensively without producing disease, a fact which is also shown in the experimental tests recorded.

Its Occurrence.—Staggers of horses is not confined to the Southern States, although it does prevail there to a greater extent than in the North. It occurs generally in a sporadic form when comparatively few animals die and the disease attracts little attention, but in certain years prevails to such an extent as to become almost epizootic in character

as was the case in this State three years ago. As has been said, it occasions serious losses to farmers in this State every year.

Nature and Cause.—This disease must be separated from that which is known to veterinarians as cerebro-spinal meningitis due to an infective agent, a disease which does occur in horses as in mankind and in which the symptoms and in some respects the lesions found *post-mortem* resemble those of Staggers. Blind Staggers, as I have seen it in this State, is not an infectious disease, but one which all the evidence shows to be intimately connected with the character of the food, or, more particularly, with the use of fungus-altered grain and forage. The characteristic symptoms, paralysis and brain disturbance, result from the action on the nerve centers, spinal cord and brain, of a chemical poison elaborated in the food by the growth of fungi. It is not believed that any one species of fungus growth is exclusively responsible for the disease, as several species of moulds, rusts and smuts possess such toxic properties. The green pencil mould, *Penicillium glaucum*, is the fungus which is much the most abundant in our cornfields and cribs and presumably the chief cause of Staggers resulting from feeding unsound corn. In those rarer cases in which similar symptoms occur in horses which are not fed grain the same or other fungus growths may be found in the forage (hay, pasture grasses, or ensilage).

Symptoms.—The attack is generally sudden. The first symptoms noticed by the owner being frequently those which have given rise to the name "Blind Staggers," that is, weakness in the hind quarters and staggering gait when walking. These are sometimes preceded or accompanied by symptoms of colic, but generally the nervous symptoms are much the most prominent although they vary considerably in different cases. Reeling when made to move, walking in

a circle, drowsiness or stupor, leaning or pushing of the head against some support, blindness, and occasionally more or less frenzy are all symptoms which may be seen in this disease. In other cases these "brain symptoms" are at first entirely absent, the horse retaining consciousness and intelligence almost till death. Paralysis begins commonly in the hind quarters and extends forward; there is some thirst but generally difficulty and later impossibility of swallowing. Bowels are usually constipated. In most cases which I have observed there has been a slight fever—up to 103° F. In two cases the temperature was below the normal. It may be said that fever is not a prominent symptom of this disease. There are comparatively few recoveries and death ensues generally in from one to three days, sometimes longer. In some cases a slow and imperfect recovery takes place. The careful observer will be able from these symptoms and the history of the case to distinguish it from most others with which it might be confounded—Cerebro-spinal meningitis, Stomach Engorgement (Stomach Staggers), Azoturia, and Sprain of Loins.

Prevention and Treatment.—If we recognize, as I have endeavored to show, that the cause of the trouble is the use of damaged grain and hay, the means of preventing it are obvious. Moulded or smutty ears of corn are easily recognized either in field or crib. These should never be fed to horses. Corn which is meant for horse feed should be carefully sorted over and only perfectly sound ears used for this purpose. It can hardly be recommended to use the moulded corn as food for cattle because these animals are also susceptible to fungus intoxication, although apparently less so than horses. When such corn must be used the risk may be lessened by cutting or knocking off the moulded part. Worm-eaten and "frosted" corn which has not become moulded, so far as we know, possesses no poisonous properties and may

be safely used as cattle feed. Rusty or mouldy oats or hay are also easily recognized and should never be fed even when moistened with water which settles the dust but does not destroy the toxic properties of such food. Finally should be interdicted the use of stagnant water of the pools and bayous which generally teem with organic impurities. In the way of treatment little can be recommended here. Purgatives in the first stages with cold applications to the head are commonly employed but with little success. In non-fatal cases recovery may be hastened by blisters to the spine and the internal use of nerve tonics, such as the salts of iron, potassium iodide, or nux vomica in suitable doses but these can hardly be used except under expert advice.

Colics of Horses and Mules.

In this article an attempt is made to give the farmer such information as he can understand and apply of the causes which most frequently lead to colics and the treatment to be adopted when such cases occur. While the bulletins of this section have for aim the diffusion of such knowledge as may be instrumental in preventing animal ailments rather than in encouraging efforts at treatment, it is from many considerations believed that in the case of colics some advice as to treatment and remedies can be recommended with advantage.

While many cases of colic in horses recover without treatment and others are inevitably fatal in despite of all treatment, the method of treatment "by expectation" or trusting to nature alone is never likely to be adopted. When an animal suffers from such acute pains as are seen in most colics, it is natural for the owner to try to give relief in some way. Unfortunately his efforts are often badly directed and do more harm than good, my experience being that in cases of colic more animals die from the effects of such misdirected

treatment than from the original disease. Under the head of "Administration of Medicines" will be found some advice both as to what to do and what not to do, which may be studied with profit.

Before attempting treatment of any disease it is necessary to make a diagnosis, that is, determine what the disease is. The name "Colic" is applied to a number of abnormal conditions of the digestive system in the horse which manifest themselves by abdominal pain. It should therefore be understood at once that all cases of colic are not alike and that a method of treatment which proves successful in one class of cases might be without effect and probably dangerous in another. For this reason it is impossible to comply with a common request which reaches me to give a "remedy for colic" which would be applicable to all cases.

Before discussing the particular forms of colic there are some remarks which may be made of colics in general both in reference to cause and treatment.

General Causes of Colic.—In some cases the causes are unmistakable, in others they can only be guessed at, but experience has shown that a large proportion of colics arise from errors connected with the feeding and management of the animal, that is, from causes which are preventable.

Predisposition.—The equine species is predisposed to colics, that is, more liable to suffer therefrom than other animals on account of certain peculiarities in the structure and relations of the stomach and intestines. Of these it may be merely said that the stomach is relatively small and incapable of emptying itself by way of the œsophagus or gullet. This lack of power of vomition (which is dependent upon anatomical construction), deprives the horse of a method of obtaining relief to the overcharged stomach (whether by food or gases), possessed by most other animals and accounts for the fatality of one frequent form of colic. The large intestines

(cœcum and colon), are of great capacity and comparatively loosely attached, circumstances which favor the accumulation of alimentary matters in their interior (Constipation) and the production of changes of relation in these organs (Twists, Invaginations, etc.). Finally should be noted the extreme sensibility of the terminal nerves of the intestines to all forms of irritants.

Exciting Causes.—Out of the large list of exciting causes of colics only those will be considered which experience has shown to be the most important and which admit of prevention. These, as has been said, consist chiefly in errors of diet. *Cold* may give rise to colic either by its action on the surface of the body or by direct action on the intestines. In the former case it occurs when animals become chilled by standing uncovered in cold weather or in a draught after sweating; also in sudden changes from dry to wet and cold weather. The internal action of cold is a more frequent cause; it results from drinking ice-cold water or eating food covered with ice or frost, these causes being especially likely to induce trouble if the horse is overheated at the time. The practice of allowing horses to drink freely of cold water immediately on coming from work and while hot is justly blamed for a large proportion of cases of spasmodic or nervous colic. Watering immediately after feeding is also a practice which cannot be commended. It may be said in general that horses should be watered before meals but when hot and sweating should not be allowed large quantities at once.

Food and Feeding.—Wrong methods of feeding or the use of bad or unsuitable food is one of the most frequent causes of colic and from a practical point of view the most important. Food of bad quality includes chiefly hay, oats, or corn imperfectly harvested or damaged by fungi (rusts, smut, moulds, etc.). Such food may give rise to nervous troubles as already described, as well as gastric and intestinal

catarrh or even acute colic symptoms. Certain other foods though not thus altered are unsuitable for horse feed from their little digestibility or liability to fermentation. They occasion stomach or bowel impactions and distention with gases. Among these may be mentioned, wheat straw or chaff, cornstalks, hay made from coarse prairie or swamp grass, pea vines, raw potatoes, and hay, oats and corn which have recently been harvested. Sudden changes from one kind of food to another is a common cause of colics, more especially from dry to green or succulent food. Full rations of grain when the animal is exhausted or hot immediately after hard work or when famished from long abstinence, also large grain rations immediately before hard or unusual exercise are well known causes of stomach impaction. Another important cause of colics is defective mastication from irregularities or disease of the teeth, especially in old horses or during the period of dentition. Intestinal worms, when present in large numbers, may also cause colic symptoms.

Other occasional causes, such as intestinal calculi, twists of the bowels, aneurisms, etc., are not practically avoidable and need not be discussed here.

General Treatment of Colics.—There are some methods of treatment applicable to all forms of colic. These may be mentioned here in order to save repetition, the symptoms and special treatment being given along with the form to which they apply. Horses attacked by colic (as well as most other diseases), should be placed under cover, best in a large and closely boarded loose box, the floor of which should be well bedded with straw. As a rule, except in cases of considerable distention of the abdomen, it is needless to attempt to prevent them from rolling; during intermissions walking exercise is beneficial except in very cold or wet weather. The body and limbs should be well rubbed with wisps of hay and when the limbs are cold a little tur-

pentine may be rubbed into them. Generally injections into the rectum of tepid water, with a little soap, are in order. These injections are made with a large syringe, carefully introduced and in quantities of about one gallon. This may be repeated at intervals if it is rejected. In cases of extreme violence or abdominal distention, something may be attempted by the aid of the halter and abundance of litter to prevent the animal from fatally injuring himself until internal remedies can be administered. In some forms of colic relief is obtained by applying blankets wrung out of hot water (not hotter than can be easily tolerated by the hand), over the abdomen. These must be kept in place and be covered by a dry blanket and must be changed before they become cold, and the skin rubbed dry when they are discontinued. In the way of internal remedies little can be recommended as applicable to all forms of colic. Animals suffering from extreme pain often throw themselves down violently and when the abdomen is distended there is then danger of rupture of bowels or stomach. In such cases morphine is the best and quickest calmative which can be used, and it is seldom out of place in acute cases of colic. It is best administered by the hypodermic syringe, although this method is not available to most of those for whom this bulletin is written.

SPECIAL FORMS OF COLIC.—The determination of the particular abnormal process which gives rise to colic pains is in some cases practically impossible during the life of the animal, while in others the symptoms and history of the case plainly indicate the nature of the trouble.

Nervous or Spasmodic Colic is one of the commonest forms. The pains in this case are produced by the erratic and powerful contraction of the walls of the intestine at some part of its course (Cramp of the bowels). In most cases it has for cause the action of cold, either externally or internally as already described. Some horses frequently suffer

from transitory attacks of such pains apparently from very slight cause.

Symptoms.—The attack is always sudden, as in most forms of colic. The horse shows the usual symptoms in these animals of abdominal pain beginning with uneasiness, striking at the belly, crouching and finally lying down and rolling. Sometimes it remains down for some minutes, lying on side or back, or at once jumps up again. The pains are not continuous. After a short time the animal seems relieved, but soon has another access of pain. There are usually frequent passages from the bowels, of small volume; sometimes there is diarrhœa and frequent attempts to urinate. The intermissions of pain and absence of bloating or distention of the abdomen, serve to distinguish this from other forms of colic. Generally nervous colics end in recovery within a few hours, sometimes in less than one hour. Others of more severity may be prolonged until they finally give rise to complications which lead to the death of the animal.

Treatment.—The advice given under general treatment of colics should be followed, namely, friction to the limbs and body, warmth, injections of warm water, etc.; no exercise is needed. The specific remedy for pure nervous colic is morphine administered hypodermically. Where the owner is in a position to make use of this remedy, it should be selected. In most cases it will be necessary to give remedies by the mouth, although this method as often employed by farmers is little less dangerous than the other. Most "colic drenches" contain stimulants and anodynes or narcotics of various kinds, such as ether, alcohol and turpentine, with laudanum, belladonna or chloroform, in considerable quantities of water or oil. On account of the difficulty and danger (to the animal) in giving drenches by inexperienced hands remedies should be preferred which can be given in small bulk. Either of the following prescriptions can be used, the

first when there is ready access to a drug store, while the other may be mixed from medicines kept on hand by the owner when located far from town. They may be repeated if relief is not obtained in one hour:

(1) Chloral hydrate, 1 oz.
Sulphate of morphine, 4 gr.
Water 10 oz.

(2) Oil of turpentine, 1½ oz.
Laudanum, 1½ oz.
Raw Linseed oil, 1 pt.

Colic by Surcharge (Acute Indigestion, Stomach Staggers, etc.), is a frequent form of colic in mules on the Southern plantations where feeding is performed in a free and easy fashion. It occurs when horses or mules are fed freely of grain immediately after hard work, or after long abstinence, or immediately before hard work, or when freely fed on any concentrated food to which they are unaccustomed. Horses which have been accustomed to dry feed are liable to suffer from stomach impaction (Grass Staggers) when first turned on to a clover or grass pasture. Under such circumstances the stomach ceases to perform its function in digestion and fermentation of the ingested food begins. This gives rise to swelling of the same, with disengagement of gases. As relief cannot be obtained by vomiting, the walls of the stomach become distended and paralyzed and the process often goes on till the organ becomes ruptured.

Symptoms.—It may be distinguished from other colics by the history of the case (its cause), by its duration, and the continuous character of the pains which rapidly become more intense. The breathing is difficult and the abdomen distended. The animal often rests on the hind quarters with the foreparts raised (like a seated dog); eructations of gas are observed, and finally vomition may occur as a presager of death. In some cases the symptoms of colic are less manifest than stupor or delirium.

Animal
College of Agriculture

Acute cases of stomach surcharge in which the symptoms quickly develop and increase in severity are usually fatal, as little can be done for the relief of the animal. Milder cases up to mere passing uneasiness are probably frequent. In severe cases drenches are swallowed with difficulty and sometimes only aggravate the trouble. The violent symptoms may be combatted by hypodermic injections of morphine and the posterior bowel relieved by enemas. It is recommended in all cases to give a purgative dose of aloes, six to eight drachms, dissolved in warm water or same amount made into a ball with vaseline. The drench prescribed for nervous colic may be used here also. Other domestic remedies used are Cayenne pepper or Jamaica ginger in half ounce doses, shaken up in milk; or infusions of tea with two or three drachms of bicarbonate of soda (saleratus) in small repeated doses.

Gaseous or Flatulent Colics, in which the large intestine becomes distended with gases, result usually from the ingestion of very fermentible food, such as new or unseasoned hay or grain. The rapid bloating or distention of the abdomen is the characteristic symptom, although bloating may also occur in other forms of colic. If unrelieved it may terminate fatally from complications due to obstructed respiration, apoplexy, intoxication by gas absorption, or by rupture of the bowel.

Treatment.—Injections frequently repeated of soap and water to which has been added about one ounce of turpentine previously shaken up in an equal amount of oil; massage of the abdomen, walking exercise, when the animal is violent hypodermic injection of morphine six grains, or if this is impossible give prescription No. 1 on previous page. Generally a purgative dose of aloes is advisable. Where relief is not thus obtained, puncturing the bowel with a small trocar is usually resorted to. It is performed somewhat in the

same way as for bloating in cattle, but cannot safely be done with a knife as in the latter case.

Colics of Constipation are less pronounced in character than those just described. The pains are moderate, the abdomen somewhat distended and the bowel passages hard and dry. There are frequent attempts to urinate. Ordinarily the animal assumes the recumbent position. Constipation may exist for many days without giving rise to colic. It may terminate fatally when the obstruction becomes absolute. It is due most frequently to drying and stasis of the ingesta in the large intestinal reservoirs. Coarse, indigestible hay (clover or prairie), pea hay, cornstalks, etc., along with want of regular exercise, tend to produce constipation. Occasionally obstruction may arise from concretions (calculi) in the bowels and also from abnormal growths (tumors) and other organic changes. Complete obstruction gives rise to symptoms of acute gaseous colic.

Constipation must be combatted by a laxative diet such as bran in the form of mashes, linseed meal, regular moderate exercise, injections and purgatives. Colic symptoms require the same treatment as gaseous colic.

Verminous colics are such as are occasioned by the presence of worms as parasites in the stomach or intestines. Several species each of round worms, tapeworms and larvæ of gadflies may give rise to symptoms of colic. Round worms when in large numbers may partially or completely obstruct the lumen of the intestine, while the larvæ of gadflies—so-called "bots"—appear in exceptional cases to occasion gastric or intestinal irritation or even obstruction of the small intestine. Colics of this kind are generally not severe, they occur chiefly in young animals which exhibit also signs of unthrift, irregularity of the bowels, and capricious appetite. Worms may also be seen in the fæces.

Treatment.—Attacks of colic should be treated by some

of the remedies already given. For the expulsion of worms a crowd of remedies are recommended none of which are successful in all cases. Either of the following may be used: Tartar emetic, two to four drachms (according to age of animal) dissolved in tepid water one quart; give this in four doses (eight ounces each time) three or four hours apart. Next day give a purge of aloes. Or, oil of turpentine two fluid ounces in six ounces linseed oil repeated on two or three successive days and followed as before by a purge. For young colts half an ounce to an ounce can be given in six to eight ounces of castor oil and the purgative omitted. In all cases worm medicines should be given while fasting and be supplemented by good food, pure water, and free access to salt. The small "pin worms" of the rectum are removed by injections of salt and water or weak tobacco infusion.

Other forms of colic dependent upon aneurisms, tumors and changes of relation of the intestines are seldom accurately diagnosed during life, little amenable to treatment, and need not be discussed here.

Administration of Medicines.—It is quite as important for those who have to treat their own stock when sick to know how medicines should be given as to know what remedies are required. The unskilled less frequently do harm from the use of improper drugs than by reckless drenching of sick horses. Such persons should never attempt to drench horses with large volumes of fluid; medicines should never be given by way of the nostrils. The remedies prescribed in this article are to be given by the mouth, rectum, or with the hypodermic syringe. The latter method will be employed only by those who are already accustomed to using it, that is by physicians or veterinarians. Rectal injections are best given by a large syringe, the nozzle of which must be well greased and no undue force employed in introducing it. Drenches are commonly given from a long-necked bottle,

the horse's head being elevated sufficiently by the halterstrap thrown over a beam. A better way is to elevate the head by a rope one end of which is fastened around the upper jaw only, hence in the mouth, and the other drawn over a pulley or beam of sufficient height. The horse should be backed into a stall when available and the end of the rope held by an assistant and never tied. Not more than two or three ounces should be poured into the back of the mouth at once and only after this is swallowed should more be given. When the animal coughs the head should be lowered.

A safer and more convenient way of giving fluids of small bulk is by means of a syringe made by inserting a cane about eight or nine inches long into a single mouthed soft rubber bulb. These bulbs hold about two ounces and may be obtained at most drug stores. The head being slightly elevated the cane is introduced into the mouth from the side, pushed back along the roof of the mouth and the contents forced out by compressing the bulb. This is repeated until the whole dose has been given. The crushing of the cane is prevented by moving the end back and forth in the middle of the roof of the mouth. For the doses prescribed in this article this method is recommended.

Balls or pills are placed on the back of the tongue, which is drawn forward with the left hand. They are carried back by the hand (which requires practice to be done with safety) or by means of a balling-gun, or simply stuck on the end of a short, not sharp-pointed, stick, but by this last method unless carefully done there is some risk of injuring the throat.

Some Further Tests of the Relation Between Cattle Ticks and Texas Cattle Fever.

In a previous bulletin (No. 20) were detailed some experiments showing how the disease of cattle known as Texas Fever was conveyed north from the infected districts almost, if not quite exclusively, by the ticks which Southern cattle

bear on their bodies. Experiments conducted at Washington (Bureau of Animal Industry), at Kansas Experiment Station (unpublished), and at this Station indicate that all cattle ticks grown on Southern cattle have within them an infective principle which they transmit to their progeny and that this is not lost in successive generations of the same year raised on Northern cattle. Northern pastures which have become infected during the summer are usually found to be safe the following year, which may result from all the ticks being killed by the cold of winter or from those that survive having lost their infective power. That the fever begetting power (for cattle) of this species of tick is not permanent is shown by this year's observations.

Young cattle ticks hatched out early in spring from eggs deposited the previous fall (See Bulletin 20) were placed (April 15th) in large numbers on a four year old horse on which they grew to maturity by May 6th to 30th. Although the experiment was not made specially to test the susceptibility of the horse to Texas Fever a careful examination was made daily to detect any signs of sickness. The horse raised a fair crop of ticks but showed no sign of Texas Fever infection. The progeny of these ticks (grown on the horse) tested during the hot weather of summer on four cattle and in two successive generations, were found to have lost all power of producing the disease. The tests were made in the same way as in the previous year, that is, by placing the larval ticks on the bodies of the cattle and carefully noting the temperature and condition of the cattle for the following month. The ticks matured on these cattle in numbers sufficient to produce disease (judging from tests of previous year), had they contained the infective agent, but no ill-health or rise of temperature was seen. It is therefore evident that these ticks had lost their infective property. From various circumstances it was impossible to make the experiments extensive enough to decide the question whether this property was lost from the process of over-wintering in this

climate or from the growth of one generation on the horse, but as other observations have shown (Texas Fever, Smith & Kilborne, p. 90) that wintering in the Northern regions does not necessarily destroy the infective power of ticks, the presumption is that the latter reason is correct.

The evidence afforded by the experiments and observations of this year go to show that in this climate the species of tick in question brought from the South rarely survives the winter; those that do over-winter pass that period in the egg.

These ticks grow to full maturity on the horse without inducing disease in their host.

The progeny of the Southern cattle ticks which have developed on the horse appear to have lost the power of infecting Northern cattle with Texas Fever, but further tests are necessary before this can be determined with certainty.

In connection with the subject of Texas Fever the more recent regulations of the Department of Agriculture concerning cattle transportation in Arkansas may be here appended in order that publicity may be given to the matter where most needed.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF SECRETARY,
WASHINGTON, D. C., August 30, 1893.

Notice is hereby given that the regulations of the U. S. Department of Agriculture, of date February 15, 1893, concerning cattle transportation, are modified, from and after September 1, 1893, so as to exclude the counties of Benton, Washington, Carroll, Madison, Boone, Newton, Marion, Searcy, Baxter, Stone, Fulton, Izard, Sharp, Independence, Lawrence, Randolph, Greene and Clay, in the State of Arkansas, from the infected area described in said regulations, and the quarantine line, established by said regulations, is hereby changed so as to place these counties north of said line; provided, that nothing in this order is to be construed to interfere with the regulations of any State affecting the movement of cattle from this portion of the State of Arkansas.

J. STERLING MORTON, Secretary.

General Condition of Live Stock in Arkansas.

From the correspondence received during the year on the subject of Live Stock and their diseases, it is inferred that, with the exception of hogs, all kinds of stock do well nearly everywhere in the State. A number of counties are reported to be unsuited for raising sheep on account of the

disease to which they succumb, while in others they do well if given sufficient care. On the whole little interest is taken in this kind of stock.

Evidently the greatest losses to the farmers of this State from live stock diseases are from cholera and other diseases of hogs. Two-thirds of the counties heard from report losses from this cause ranging from a few animals to nearly all the hogs in the locality. Of the causes given for these losses the most common are lack of attention, impure water, starvation, acorns, and cotton seed, all of which no doubt contribute their share, but the most important source of this fatality in hogs is the neglect of all precautions to keep healthy animals from mixing with the diseased.

Those who have reported skin diseases of hogs are referred for advice to Bulletin No. 20.

Horses have been unusually healthy during the year, the only diseases of any consequence reported being Staggers, Colic and "Foot-evil." Glanders is reported in three counties.

Cattle died in considerable numbers in St. Francis and Lee Counties from Texas Fever during the summer. Other diseases of cattle complained of are "Murrain," "Hydrophobia," an epizootic form of Ophthalmia, and a disease of the lungs caused by the presence of worms. These two latter diseases are quite prevalent in many districts and will be investigated and reported on in a future bulletin.

NOTE.—The impossibility in this State of obtaining expert advice on the treatment of animal diseases renders it necessary that the farmer should himself know something of this subject. It is with the aim of supplying such information that this bulletin is issued. Letters from residents of the State asking information on live stock diseases will be answered from this Station as heretofore. In reply to those who have asked for the names of books on this subject the following may be mentioned as especially written for farmers. Government publications are free and can be obtained (if editions are not exhausted) by application to your Congressman or U. S. Senator or to the Agricultural Department at Washington.

Special report on Diseases of the Horse.—U. S. Department of Agriculture, 1890.

Special report on Diseases of Cattle and Cattle Feeding.—U. S. Department of Agriculture, 1892.

The Farmer's Veterinary Adviser.—Prof. Jas. Law, Ithaca, N. Y. List price, $3.00.

R. R. DINWIDDIE.

Apple Scab.

This disease is generally known over the State and it is inferred that fruit growers are familiar with it. But for the benefit of those not familiar with the disease and who wish to be able to recognize it, a short description is here given.

The disease causes the brown or black scabs that are noticed on the apple. These scabs have a rough, hard surface and are composed of a corky, hard material. The edges are jagged and rough and are of a grayish appearance. This disease must not be confused with bitter rot, in which the surface of the apple and the flesh immediately beneath it are decayed. The flesh of the apple under the scab is firm and differs in appearance from that of a healthy apple only in having a more greenish tint.

In combating all fungus diseases it is essential that something of the life history of the disease be known, thus enabling us to determine the proper time to apply remedies for preventing it. From what is known of apple scab it is believed that the trees are affected early in the season. The disease is reproduced by means of spores which are carried to the healthy plants by the wind and in other ways. The spores live through the winter in the rubbish, old leaves and fruit and under the rough bark of the trees and are ready to begin the attack as soon as the leaves open in the spring. The condition of the atmosphere here is very favorable for the development of the disease at an early date.

The spores germinate, grow and produce new spores, which are blown to healthy leaves and fruit. Thus the development is kept up, if the weather is favorable, throughout the growing season. The scab thrives best in cool, damp weather. A continued dry spell checks the development of the disease.

The leaves are attacked quite early and the disease is recognized by roundish, olive green spots on them. These spots run together and form large blotches as the disease advances. The first indication of scab on leaves last year was noticed about May 6th. On the fruit the disease is often noticed while the apples are quite small but not for some time after the leaves are affected. It is to the fruit that the disease does the main damage.

APPLE AFFECTED WITH SCAB.*

Spraying for Apple Scab.

The importance of preventing the apple scab by applying some poison by means of a spray has caused much investigation and experiment work to be done during the last few years. Good results have followed and remedies can now be recommended with the assurance that they will prevent the disease to a great extent. The copper salts have proven the best remedies of all the materials tested and are generally recommended for the apple scab and other fungus diseases, especially those attacking the grape. The copper salts must be applied in such a combination that they will adhere to the parts and remain on them even during wet weather.

*This cut was made by the Wisconsin Exp. Sta

From the nature of the disease and the method of reproduction and attack on leaves and fruit it is evident that a remedy to be effective must be present on the surface to kill the spores as they come in contact with it—that is, before they germinate. After germination takes place and the spores have entered the tissue of the leaf or fruit they cannot be reached from without by any poison and any amount of spraying will not kill them. Thus, to be most effective, spraying must be done early, so that the fungicide is present on the surface when the spores begin the attack and the applications should be repeated from time to time as long as there is danger of infection.

Time to Spray. No set rule as to time of applying mixtures can be given. The time of applying and the number of applications will vary with the locality and the season. The first spraying, given before the leaves open, is found to be very beneficial. The trees are easily sprayed at this time and but little of the mixture is needed to effectually do the work. The second spraying is given soon after the blossoms fall and a third in about twelve days after; a fourth in about a month if necessary. The number of applications will depend much upon the season and the prevalence of the disease. Later applications are especially beneficial where the crop is damaged by bitter rot.

Fungicides. For the first spraying (the one given before the leaves open), the simple solution of copper sulphate is best. This solution is easily prepared and is cheaper than the others. It is also as effective, but it should not be used after the leaves open as there is danger of injury to the foliage. For the second and third applications use Bordeaux mixture and Paris green or London purple, as the insecticides can be applied in combination with the fungicide and thus save one-half the labor that would be necessary to make the applications separately. The later applications may be made

with either Bordeaux mixture or ammoniacal solution. When spraying is done near the time of ripening, use Ammoniacal solution in preference to the Bordeaux mixture as it does not injure the appearance of the fruit.

The formulas for fungicides and their preparation were given in Bulletin No. 21 of this Station. However, for convenience, part of them will be repeated here.

Bordeaux Mixture. This mixture has proved to be the best fungicide for all purposes of any of the copper salts and is the one most generally used. In Bulletin No. 21, three formulas were given for this mixture. But formula II. is found to give as good results as either of the others, is cheaper and can be more easily applied. The formula is:

Sulphate of copper (Blue stone) ..... 6 pounds.
Lime ..... 4 "
Water ..... 45 gallons.

To prepare this mixture dissolve the copper sulphate in four gallons of water. This is best done in a barrel and should be left for several hours if cold water is used as it is slow to dissolve in cold water. But if hot water be used it can be quickly dissolved. To facilitate the work it is best to buy the powdered sulphate as it costs but little more. If this cannot be done hot water should be used. Pour boiling water upon the sulphate in a wooden vessel. Fresh lime thoroughly slaked should be used. To this add three or four gallons of water and strain into the copper solution. It is important that it should be carefully strained as large particles interfere with the work of the nozzle. To the mixture add enough water to make the required strength. If four or five pounds fresh lime cannot be had, six pounds of partially air slaked lime might be used to advantage.

Ammoniacal solution of copper carbonate is often used as a substitute for Bordeaux mixture and on account of its not damaging the appearance of the fruit is used for the late

sprayings. This solution is more easily applied and it is less trouble to prepare for use than the Bordeaux mixture. From a comparison of results obtained from its use here and elsewhere it could not be recommended, however, as a substitute for the Bordeaux mixture except for the late sprayings.

The formula is:

Copper carbonate ..... 5 ounces.
Aqua ammonia ..... 3 pints.
Water ..... 45 gallons.

To prepare for use mix the copper carbonate with enough water to make a thin paste. Add the three pints of ammonia and if that will not dissolve the paste add enough more to bring about that result. To this add forty-five gallons of water. This solution should be used when first prepared.

Simple solution of copper sulphate is found valuable for spraying the trees and vines before the buds open. Owing to the ease with which it is applied it is the best fungicide to use for the early spraying.

The formula is:

Copper sulphate ..... 1 pound.
Water ..... 25 gallons.

Insecticides. When applying fungicides for apple scab the insecticides for the apple worm or codling moth can be used in combination with them at no additional expense except the cost of the poison. Fully as good results follow their use when used in combination as when used separately. The two insecticides used for this purpose are Paris green and London purple. Their value depends upon the amount of arsenic they contain. They are practically insoluble in pure water and are preferable to white arsenic which is sometimes used for this purpose but owing to its slight solubility it is not safe to use it on account of its injury to foliage.

The strength recommended is one pound of the arsenites to two hundred gallons of water, or about one quarter of a pound per barrel, when used alone, but when used in combination with Bordeaux mixture or when freshly slaked lime is added it may be safely used in one pound to one hundred and sixty gallons of water.

Care must be taken not to spray before the blossoms fall. The importance of this cannot be too strongly urged, as it is destructive to insects so important to the thorough fertilizing of the flowers and it does not prove so effectual as the poison is liable to be washed off before it is needed to kill the worms. Furthermore it is highly injurious to bee keepers in the vicinity by destroying the bees.

Spraying Experiments.

To practically test spraying for apple scab an experiment was carried on by the Station last year. Two orchards that had been damaged to a great extent in previous years by the disease were selected for the test. Trees of the winesap variety were selected, as this is one of the worst varieties to scab in this section. Two orchards were taken so that one would be a check for the other. One was under cultivation; the other was not.

Orchard No. 1, owned by Mr. Lea, is an old orchard, the trees being twenty years old, It has been in a good state of cultivation for the last three years. Previous to that it had been without cultivation for nine years. The trees are large and healthy and had been carefully pruned the previous winter. Owing to a difference in the character of the soil and situation the trees were grouped so that the check tree and those sprayed in each group were under the same conditions, as well as being similar as regards size and appearance.

Fifteen trees were selected in this orchard for the test. Nine were sprayed and six left as checks. They were divided into six groups, thus giving one check for each group. The balance of the orchard, which comprises about nine acres, was sprayed during the season by the owner. In giving the results of the experiment each group is numbered in the table and is considered independently. Bordeaux mixture according to the formula given elsewhere was used for all the sprayings and proved the best fungicide. An Excelsior nozzle was used and did the work well. The pump used is one manufactured by the Field Force Pump Co. The amount of mixture given each tree was about five gallons at each spraying. The first application was given April 26th. The blossoms had all fallen, the majority perhaps one week previous. There were no signs of scab on leaves at this time. The second application was made May 11th. At this time the scab had started and was on the leaves of the check trees to quite an extent. A small amount of scab was noticed on the leaves of the sprayed trees but the disease had not attacked the fruit of either set. When the third application was given, June 5th, the scab had secured a strong foothold on the check trees, both on the leaves and fruit. On sprayed trees there was no increase of scab over that at the time of second spraying, neither had it attacked the fruit.

TABLE I.

Record of Fallen Apples Picked from under trees during the Season.

		August 5.	August 14.	August 21.	August 29.	September 6.	September 14.	September 21.	September 29.	Total Number Fallen.
GROUP I.	Sprayed	92	60	80	93	58	87	117	182	769
	Unsprayed	117	26	14	40	26	79	37	38	377
GROUP II.	Sprayed	60	17	46	57	29	68	124	134	535
	Sprayed	59	27	50	56	50	82	92	141	357
	Unsprayed	125	26	42	28	36	67	38	38	400
GROUP III.	Sprayed	90	27	76	94	37	115	225	276	940
	Unsprayed	529	93	129	83	85	270	100	119	1408
GROUP IV.	Sprayed	22	4	15	24	14	25	55	149	308
	Sprayed	58	26	64	86	53	84	121	161	653
	Unsprayed	650	128	110	91	87	150	113	167	1496
GROUP V.	Sprayed	102	35	74	60	49	65	70	70	525
	Unsprayed	489	93	90	93	48	90	58	80	1041
GROUP VI.	Sprayed	116	38	77	80	99	129	234	294	1067
	Sprayed	99	65	106	121	75	118	197	200	981
	Unsprayed	697	87	144	119	80	115	122	119	1483

In order that the total number of apples borne by each tree in the experiment be known the windfalls were all picked from under the trees, counted and carried from the orchard on the dates given in the table. The average number of apples that fell from the check trees was 1,034, and from the sprayed 704. There was considerable difference in the value of the windfalls from the two sets. From the sprayed trees the apples that fell after the third gathering were carried to the fruit house where most of them were evaporated and the remainder were made into cider. From the check trees the

fallen apples were almost worthless. Only a small per cent were fit for evaporating or cider.

That a large proportion of the windfalls from the unsprayed trees fell during the early part of the season is clearly shown from the table. With the sprayed trees the greater portion fell later in the season when they were sufficiently large for use.

TABLE II.

Apples gathered from trees September 29.

		Number Scabby.	Number Not Scabby.	Total Number Gathered.	Total Number Fallen Apples from Table No. I.	Total Number Borne on each tree.
GROUP I	Sprayed	32	665	697	769	1466
	Unsprayed	84	0	84	377	461
GROUP II	Sprayed	64	978	1042	335	1373
	Sprayed	41	356	397	557	954
	Unsprayed	42	7	49	400	449
GROUP III	Sprayed	9	574	583	940	1523
	Unsprayed	318	4	322	1408	1730
GROUP IV	Sprayed	14	253	267	308	575
	Sprayed	20	894	914	653	1527
	Unsprayed	556	24	580	1496	2076
GROUP V.	Sprayed	63	205	268	525	793
	Unsprayed	318	13	331	1041	1372
GROUP VI	Sprayed	47	1138	1185	1067	2252
	Sprayed	12	661	673	981	1654
	Unsprayed	356	125	681	1483	2164

From Table II. it is seen that a considerable difference exists between the number of apples gathered from the sprayed trees and from the checks. The average number from the sprayed trees is nearly twice that from the checks.

Counting the fallen apples and those gathered from the trees the average number that grew on the sprayed trees this season was 1,351 per tree while on the check trees the number was 1,375 per tree, showing that the check trees averaged a few more apples than the sprayed trees, but at gathering time the average number of apples picked from each sprayed tree was 647, while the average number picked from each check tree was 341.

The apples showing scab from the sprayed trees were five per cent, and from the unsprayed ninety-one per cent. In other words, ninety-five apples in every hundred from the sprayed trees were free from scab, while from the unsprayed trees only nine in each hundred were unaffected.

The sprayed trees yielded an average of two and three-fourths bushels per tree of marketable apples, while the unsprayed trees averaged one and three-eighths bushels per tree and only thirty-five per cent of it was marketable or less than one-half bushel of marketable apples to the tree. The remaining sixty-five per cent was a poor grade of cider apples. The cost of spraying was seventeen cents per tree, and the increase in marketable apples was two and one-fourth bushels, making a cost of less than eight cents per bushel.

Orchard No. 2. This orchard, owned by Mr. Duncan, is about seventeen years old. It has not been under cultivation for several years but the trees are large and healthy. No difference in the soil could be detected and of the four rows taken for the experiment two were left for a check, the sprayed and the unsprayed alternating. Of the sprayed trees there were thirteen; of the unsprayed, eleven. The dates of the sprayings were April 27th, May 13th and June 3d. The amount of the mixture given each tree averaged about the same as in orchard No. 1.

The results in this orchard correspond so closely with those obtained in orchard No. 1 that they will not be given

in detail. The proportion of scabby fruit is somewhat less in this orchard than in the other, as is also the amount of scab on the sprayed fruit. The number of scabby apples on the check trees was eighty-nine per cent of the apples gathered. The number of scabby apples on the sprayed trees was three per cent. Thus from the sprayed trees we have ninety-seven per cent of the fruit free from scab and eleven per cent free from the disease on the check trees. All of the fruit from the sprayed trees was sold to shippers and was therefore classed as marketable. Forty-two per cent of the fruit from the check trees was marketable.

Bitter Rot.

This disease causes considerable loss in this State. From the reports received it is inferred that the loss is not confined to any particular section. The disease does not attack the fruit until it is nearly or quite ripe, and often is not noticed to any alarming extent till after the fruit has been gathered and stored. It was more general in this section in 1892 than last year.

This disease is first noticed as small specks or spots of brown color on the surface of the apple. They grow very rapidly until the whole surface is covered. The spots are a little sunken and the center is thickly covered with black pustules. These are arranged in circles over the surface, giving it the appearance of several concentric rings. Sometimes the pustules are not black. Fruit taken from a cave in this vicinity after being stored but a few weeks showed pustules of a light brown color and the entire spots were light in color. The bitter taste of the rot aids in distinguishing it.

Remedies. The fungicides used for preventing apple scab and other plant diseases are in all probability more or less effective in preventing this disease. No experiments

were carried on for the purpose of preventing this disease this year but results obtained in this connection from the work for apple scab are here given.

There was no bitter rot on the check trees in orchard No. 1, but in orchard No. 2 there was considerable damage from the disease. On each of the eleven check trees there were a number of apples damaged by bitter rot. It had only started at gathering time and the spots were small. On eleven trees sprayed three times there was only one apple that showed bitter rot. On two trees sprayed twice there was one-half as many apples affected with the disease as on the check trees. It is inferred from these results that the third spraying prevented the disease in a large measure and also that the spraying for the scab almost entirely prevented the bitter rot.

Test of Keeping Qualities of Sprayed and Unsprayed Fruit. On October 2d several boxes of apples from orchard No. 1 were placed in a room at the Station for the purpose of comparing the keeping qualities of sprayed and unsprayed fruit. The apples of each class were average specimens and free from worms. The boxes were placed in a closed and darkened room of the Station building. The room is on the east side of the building and near the north end so that it was moderately cool even through October. On November 30th the fruit was examined, sorted and all decayed or partially decayed apples removed. Of the sprayed fruit seven per cent was found to be decayed and of the unsprayed fruit forty-two per cent. The remainder of the sprayed fruit was sound and in good condition while the remainder of the unsprayed fruit was shrunken, wilted and almost entirely unfit for use. On January 22d the fruit was again examined and sorted. Thirty-three per cent of the sprayed fruit was partially or wholly decayed; the remainder was firm and sound. Fifty-

three per cent of the unsprayed fruit was decayed, while the remainder was partially decayed.

The results of a similar experiment carried on by Prof. Lodeman are given as reported in Bulletin No. 60, of the Cornell Experiment Station:

"A few Fall Pippin and Maiden's Blush apples were selected from the sprayed and also from the unsprayed portion of the trees about September 20th. Bordeaux mixture had been used upon the former. They were stored in a cool, dry cellar. On the 15th of October the unsprayed apples began to show signs of shriveling. The scabby portions were depressed and some days later showed signs of decay. November 18th the unsprayed apples were much shriveled and somewhat decayed. The sprayed apples which were exceptionally fine specimens, were still plump and fit for market. It is possible that the keeping qualities of apples may be considerably affected by proper applications."

General Results. The value of the fallen apples from the sprayed trees for evaporating and cider over those from unsprayed trees, was more than enough to pay for the spraying, thereby leaving the increase of marketable apples due to spraying as profit.

The fruit from sprayed trees was practically free from scab and nearly twice as many apples were on them at gathering time as were on the unsprayed trees. From the experiments this year it is inferred that three or four sprayings are sufficient to prevent the scab. The trees sprayed but twice gave about the same per cent free from scab as those sprayed three times, but the apples were not so large as those sprayed three times.

The apples from sprayed trees were larger and more even than those from unsprayed, and the sprayed fruit was heavier.

Cost of Spraying. Three applications cost about seventeen cents per tree.

Tables showing the weather during the season are found on last pages of the Bulletin. These tables are from the weather record kept by Prof. G. L. Teller. In the tables FAIR means PARTLY CLOUDY.

Results of Spraying for Apple Scab at Other Stations.

A table showing results of four and six applications of Bordeaux mixture on Fall Pippin and Maiden's Blush apples respectively, taken from Cornell Bulletin No. 60, is here given.

FALL PIPPIN.

Number of Applications.	Per Cent 1st Class.	Per Cent 2d Class.	Per Cent Cider.	Per Cent Wormy.	Weight in lbs. of 100 Apples.
6	61	35	4	4	46
None.	1	30	69	12	27

MAIDEN'S BLUSH.

4	48	35	17	2	37¾
None.	15	27	58	13	24½

In regard to fungicides Prof. Lodeman says of the Bordeaux mixture in Bulletin No. 60:

"In no case did any other fungicide give results which approached in excellence those obtained from this mixture. Nor is its value fully shown by the number of apples in the various grades, for the general appearance of these apples was so superior that the fruit of the Bordeaux lots could be identified at sight almost with certainty. This superior appearance was mainly due to the uniform size of the apple, their regular form and the smoothness of the skin."

In giving the comparison of size of sprayed and unsprayed fruit, he says:

"But the Maiden Blush apple showed what could be done. There is only one tree of this variety in the orchard and this year it bore a fair crop. One-half of this tree was sprayed with Bordeaux mixture and the other half was not touched. When harvested a hundred average apples of the unsprayed side weighed 24½ pounds while an equal number similarly chosen from the other half of the tree weighed 37¾ pounds; a gain of over fifty-four per cent. This difference was forcibly shown in another way; in fact, so plainly and conclusively did it show the value of spraying apples susceptible to the attacks of the scab that it alone would convince the most skeptical that the operation is a paying one. One hundred average unsprayed apples filled a half bushel basket evenly full. One hundred of the average sprayed apples filled a bushel basket evenly full. Thus the bulk of the crop of Maiden Blush was practically doubled."

Prof. Garman, in Kentucky Experiment Station Bulletin No. 44, says:

"On two occasions, May 23d and June 6th, after spraying the trees on which we were making regular observations, the surplus Bordeaux mixture was sprayed upon a Janet tree which stood near, being one of several in a row. It was noticed from time to time that its leaves and fruit appeared to be in better condition than those of its fellows of the same variety, but it was given no further attention until the time of picking, October 8th, when the apples from this tree and those from another one as nearly like it as could be found were compared. It was found that the apples on the sprayed tree averaged considerably larger and were comparatively but little injured by the scab. Of 143 pounds of the fruit from this tree 45½ (31 1-10 per cent) pounds were scabbed. The apples from the check tree were almost worthless, being small and misshapen, and of sixty-seven pounds taken from the tree there was not a single apple that was not scabbed."

THE PREVALENCE OF APPLE SCAB AND BITTER ROT IN THE STATE.

Subjoined, are reports from counties in the State as regards apple scab, bitter rot, and the varieties of apples which are the surest bearers:

J. L. Edwards, DeWitt, Arkansas County.—"No apple scab in cultivated orchards. In outdoor orchards about fifty per cent damaged. No bitter rot. The surest bearers are Ben Davis, Mammoth Black Twig, Arkansas Black and Janet."

R. F. Tucker, Hamburg, Ashley County.—"Considerable damage from apple scab and bitter rot. Surest bearers are Shockley, Summer and Winter Pearmain and Nickajack."

O. L. Dodd, Mountain Home, Baxter County.—"Apple scab damages the crop to a limited extent only. Surest bearers, Winter Pearmain, Ben Davis, Limbertwig, Shockley and Arkansas Black."

D. Wing & Bro., Rogers, Benton County.—"Considerable damage from apple scab, especially to Winesap and Arkansas Black varieties. Also damage from bitter rot. Surest bearers are Ben Davis, Mammoth Pippin, Maiden's Blush and Winesap."

Spraying. In our own orchards we have sprayed for several years with complete success, having this year a full crop of perfect apples, hardly a wormy one to be found.

P. A. Rodgers, Clemantine, Benton County.—"Twenty-five per cent of fruit damaged by apple scab and it is not confined to any certain varieties. Some damage from bitter rot. Surest bearers, Ben Davis, Limbertwig, Red June and Horse."

Spraying has been done by ten per cent of the farmers with good results.

Alvin Dickinson, Bentonville, Benton County.—"Twenty-five per cent of the apple crop damaged by scab. The varieties most subject to it are Winesap, Arkansas Black and White Winter Pearmain. Some damage from bitter rot. Surest bearers, Ben Davis, Limbertwig, Mammoth Pippin, W. W. Pearmain and Missouri Pippin."

Spraying. Forty per cent of the larger orchards were sprayed but owing to wet season the results have not been very satisfactory.

G. A. Gamble, Harrison, Boone County.—"Apple crops are seriously damaged by scab. The varieties Arkansas Black and Winesap are the worst damaged. There is some damage from bitter rot. Surest bearers are Ben Davis, Shockley, Winesap, Mammoth Blacktwig, Limbertwig and Minkler."

Spraying. Orchards were sprayed this season and the codling moth defeated, but spraying against bitter rot was not successful.

J. H. Abernathy, Warren, Bradley County.—"Am not acquainted with the disease called apple scab. However, the apples rot before they ripen. Surest bearers are Red June, Horse and Yates."

P. H. Marbury, Hurn, Clark County.—"Some damage from apple scab but not to any great extent. The variety most damaged is Winesap. Damage from bitter rot to a great extent. Surest bearers are Ben Davis and Arkansas Black."

J. L. Bozeman, Arkadelphia, Clark County.—"No damage from apple scab, but almost a total destruction to all late varieties from bitter rot. The surest bearers are Red June, Early Harvest and Horse."

Spraying has been done to a limited extent with beneficial results.

J. W. Broke, Rector, Clay County.—"Nearly one-half the apple crop is damaged by the apple scab. The most damage is confined to the fall varieties. Some damage from bitter rot. The surest bearers are the summer apples."

G. D. Milner, M. D., Milner, Columbia County.—"Fully three-fourths of the crop is damaged by the apple scab, also some damage from bitter rot. The surest bearers are the summer apples."

J. P. Shultz, Cash, Craighead County.—"The late varieties are damaged by the apple scab, but the bitter rot does the most serious damage of all the diseases."

M. Frank H. Smeltzer, Van Buren, Crawford County.—"The damage from apple scab is about fifty per cent: The varieties most damaged are Ben Davis, Shockley and Shannon. Some damage from ripe rot. The surest bearers are Shockley, Winesap and the early varieties."

Dr. W. L. Gullett, Van Buren, Crawford County.—"Apple crop is badly affected in some parts by scab. The fall and winter varieties are most damaged. Surest bearers are the early varieties."

Spraying. The few experiments of this year resulted so favorably that there will be a large increase next year of spraying.

J. M. Neel, Princeton, Dallas County.—"Some damage from apple scab and bitter rot. The surest bearers are Ben Davis, Limbertwig and Red and Yellow June."

S. J. Mathews, Monticello, Drew County.—"No damage from apple scab, but there is some from bitter rot. The

surest bearers are Red Astrachan, Early Harvest, Horse, Taunton, Yates and Shockley."

M. E. Moore, Greenbriar, Faulkner County.—"About twenty-five per cent of the apple crop is damaged by scab, nearly all varieties are damaged about the same. Bitter rot attacks the fruit to some extent. Surest bearers are Early Harvest and Red June."

A. W. Pool, Ozark, Franklin County.—"No damage from apple scab and but a small per cent of damage from bitter rot. Surest bearers, Ben Davis, Winesap, Shockley, Early Harvest and Summer Queen."

F. L. Massey, Hot Springs, Garland County.—"Hardly any damage is noticeable from apple scab. Some from bitter rot, however. Surest bearers, Ben Davis and Shockley."

Spraying. What spraying has been done has been a success.

William Sheppard, Belfast, Grant County.—"About twenty-five per cent of our apple crops are damaged by the scab. The varieties most damaged are Shannon, Horse and Yellow Pippin. Some damage from bitter rot. Surest bearers are Tull, Ben Davis, Shockley and Pride of Texas."

T. J. McClendon, Nashville, Howard County.—"Apple scab does damage to the apple crop in all sections of the county. The varieties most damaged are Winesap, Ben Davis, Kentucky Streak and Shockley. Bitter rot does damage to some extent. The surest bearers are Red June, Early Harvest, Horse, Buckingham, Kentucky Streak, Arkansas Black, W. W. Pearmain and Shannon."

W. J. Arnold, Melbourne, Izard County.—"The apple crops are damaged about twenty per cent by scab. The varieties most subject to it are Ben Davis, Northern Spy, Smoakhouse and Shannon. Some little damage by bitter rot. The surest bearers are Winesap, Ben Davis, Limbertwig, Rome Beauty and Rambo."

Spraying. Very little has been done but it has been followed with good results.

M. N. Erwin, Auvergne, Jackson County.—"About one-half of the apple crop is damaged by the scab. Some damage this year by bitter rot. The surest bearers are Early Harvest, Red June, Horse, Limbertwig, Winesap, Arkansas Black and Rusty Coat."

F. A. Hahn, Lutherville, Johnson County.—"All varieties are damaged to some extent by apple scab, some varieties nearly one-half, while Shockley and Ben Davis about one-fourth. The varieties most damaged are Winesap, Limbertwig and Willowtwig. Considerable damage from bitter rot this year. The surest bearers are Winesap, Ben Davis, Shockley, Ingram, Buckingham and all the June apples."

Geo. P. Murrell, Austin, Lonoke County.—"Three-fourths of the crop from winter varieties are damaged by apple scab. The varieties most damaged are Kentucky Streak, Shannon, Nickajack and Ben Davis. Some varieties are badly damaged by bitter rot while others are not. All northern varieties are badly affected while southern varieties are but little. Surest bearers are Red June, Sops of Wine, Ben Davis, Yates, Shockley and Virginia Greening."

L. E. Parker, Aurora, Madison County.—"Some varieties are badly affected by apple scab. Those most damaged are Winesap, Limbertwig and Shockley. Very little damage from bitter rot. Surest bearers are Ben Davis, Limbertwig, Winesap, Shockley and Shannon Pippin."

R. W. Perry, George's Creek, Marion County.—"Are not troubled with apple scab in this county to my knowledge, but the apple crop is badly damaged by bitter rot. Surest bearers are Maiden's Blush, Summer Queen, Early Harvest, Red June, Ben Davis, Shockley, W. W. Pearmain and Wisesap."

J. B. Fulton, Mount Ida, Montgomery County.—"The apple crop is damaged to a considerable extent by the scab. The varieties most damaged are Shockley and Smith's Cider. There is also much damage from bitter rot. The surest bearers are Shockley, Red June, Smith's Cider and Lawrence Seedling."

W. S. S. Snow, Snow, Newton County.—Not much damage from either scab or bitter rot. The varieties damaged most by scab are Willowtwig, Red Limbertwig and Twenty-Ounce Pippin. Surest bearers are Kentucky Red, Red Limbertwig and Maiden's Blush."

W. E. Jenkins, Camden, Ouachita County.—"Very little damage is noticed from apple scab. The varieties most damaged are Ben Davis and Red Astrachan. Our worst foe is the bitter rot. Surest bearers are Red June, Horse, Buckingham, Shockley and Winesap."

Moses Burke, La Grange (Lee Co.), Phillips County.—"Owing to apple scab and blights we have almost given up apples. Hardly any varieties seem exempt that we have tried. Also some damage from bitter rot. Surest bearers are June apples, Limbertwig and Russett."

A. M. Reinhardt, Hickory Plains, Prairie County.—"Some damage from apple scab and bitter rot of the apple. Most all varieties are damaged. Surest bearers are Red June, Horse, Yellow May, Red Astrachan, Leather Coat and Winesap."

Barna B. Rogers, Little Rock, Pulaski County.—"Very little apple scab. Probably about ten per cent, and about fifty per cent of the crop is damaged by bitter rot. The varieties most damaged by the scab are Winesap, Ben Davis, Rome Beauty and Willowtwig. The surest bearers are Shockley, Hall's Seedling, Red Astrachan, Red June, Tull, Horse and Winesap."

G. H. Coleman, Fort Smith, Sebastian County.—Considerable damage from apple scab. Owing to it the crop in some localities was worthless for market last year. The varieties most damaged by the disease are the winter apples. The apple crops are badly damaged by bitter rot."

Spraying. I sprayed a few trees last year with good results, using Bordeaux mixture.

William Stromöerg, Fort Smith, Sebastian County.—"Very little damage from apple scab but considerable loss from apples rotting on the trees before they are ripe. Surest bearers, Early Harvest, Red June, Red Astrachan and Yellow Transparent. They all bear well enough but winter apples on old trees rot and fall before they get ripe."

John J. Estes, Ash Flat, Sharp County.—"Some damage from apple scab, probably ten per cent. Also damage from bitter rot. The varieties most damaged by scab are Winesap, Ben Davis and Northern Spy. The surest bearers are Winesap, Early Harvest and Grindstone."

Spraying is the only redemption for the apple here.

Edward C. Horn, Latham, Van Buren County.—"Considerable damage from apple scab. The varieties most damaged are Winesap, Shockley, Vandevere and Lawver. The surest bearers are Kentucky Streak, Winesap, Shockley, Red Limbertwig and Yellow Belleflower."

William Hatley, Latham, Van Buren County.—"Some varieties are nearly a failure owing to the apple scab. The varieties most damaged by it are Winesap, Shockley and Lawver. There is some damage from bitter rot in orchards not cultivated. The surest bearers are Winesap, Ben Davis, Shockley and Jeniton."

F. L. Doubrava, Judsonia, White County.—"The apple crop is badly damaged by scab to an extent of about fifty per cent. The varieties most damaged are Shockley, Grindstone, Nickajack and Ben Davis. The crop is also badly

damaged by bitter rot. The surest bearers are Early Harvest, Pearmain, Taunton and Yates."

Joseph Evins, Mount Nebo, Yell County.—"The damage from apple scab amounts to about twenty-five per cent. The varieties most damaged are Shockley, Rome Beauty and Ben Davis. The surest bearer is Ben Davis."

Some Apples Adapted to all Sections of the State.

For the benefit of those desiring to plant new trees a short list of varieties found suitable for all sections of the State is here given together with a description of them as found in standard works on the apple.

Summer Apples.—Carolina Red June (Red June, Blush June and other names). Tree very vigorous, upright and an early abundant bearer. Fruit ripens a few days after Early Harvest and is below medium in size, oval, irregular and inclining to conical. Skin smooth, color red, flesh white, tender, juicy, subacid.

Early Harvest (Yellow Harvest, July Pippin, Princes Harvest, Early French Reinette and others). Tree a moderately vigorous grower, upright and spreading, productive. Fruit medium, roundish, somewhat oblate. Skin smooth with a few faint white dots. Bright straw color when ripe. Flesh very white, tender, juicy, with a rich slightly subacid flavor.

Red Astrachan. Tree a vigorous grower, upright and spreading. An early bearer, productive. Fruit medium to large, somewhat conical, rather smooth. Color deep crimson covered with a pale white bloom like a plum. Skin smooth. Flesh white, crisp, moderately juicy with an agreeable acid flavor.

Maiden's Blush. Tree a rapid grower with a spreading top. Good bearer. Fruit medium, oblate, smooth and

very regularly shaped. Skin smooth. Color pale yellow with a red blush. Flesh white, tender, sprightly, pleasant subacid but not rich.

Summer Queen. Tree large, spreading, with branches somewhat bending. Good bearer. Fruit large, roundish, conical, quite broad at the base. Color deep yellow ground but well striped and clouded with red. Flesh yellowish, acid, spicy and rich. Fine for cooking.

Horse. (Haas, Summer Horse.) Tree vigorous grower and an annual bearer, productive. Fruit large, roundish to oblate. Color yellow, sometimes tinged with red with small patches of russet. Flesh yellow, rather coarse pleasant subacid.

Fall Apples.—Buckingham. (Fall Queen, Kentucky Queen, Equinetly, Winter Queen, Queen, Red Horse and many other names.) Tree hardy, healthy, moderately vigorous and productive. Upright with a spreading top. Fruit medium to large. Oblate, inclining to conic. Color greenish yellow, ground covered and striped with red, with light brown spots over surface. Flesh yellowish, rather coarse, tender, juicy, mild and sprightly, subacid. Very good.

Taunton. Tree vigorous but straggling grower. Productive. Fruit rather large; oblate to conic. Color greenish yellow striped and splashed with red, darkest on side next to sun. Large, light dots on the surface. Flesh whitish, tender, juicy, acid. Good.

Indiana Favorite. Tree good grower, spreading top and an abundant bearer. Fruit medium, roundish and flattened at the end. Color yellow ground, shaded and streaked at the end, covered with russet specks. Flesh white, tender, juicy, vinous, almost sweet. Good.

This apple is a small apple here, and is a good keeper. Apples of this variety were on the tables at the Arkansas ex-

hibit in Chicago for weeks without showing any signs of decay. It is said to be very productive where grown in the State.

Johnathan. Tree hardy and moderately vigorous, upright and spreading. Productive. Fruit medium size, regular, roundish to conical. Skin thin and smooth. Light yellow, nearly covered with red stripes, which becomes a very dark red in the sun. Flesh white, sometimes a little pinkish. Very tender and juicy, with a mild, sprightly, vinous flavor. Fine dessert apple. Quality, best.

Winter Apples.—Winesap. Tree grows rather irregularly. Comes into bearing early and is productive. Fruit medium in size, roundish, oblong, skin smooth. Color yellow, streaked and covered with dark red. Flesh yellow, firm and crisp, with a rich subacid flavor. Nearly acid. Quality good.

Ben Davis. (New York Pippin, Kentucky Streak, Kentucky Pippin, Victoria Red, Carolina Red Streak and others.) Tree a good grower, upright, bears early and abundantly. Fruit medium to large, roundish to conical. Color yellowish, almost entirely overspread and striped with two shades of red. Flesh whitish, tender, moderately juicy, subacid.

This apple does well over the Southwest, and, owing to the productiveness of the trees and the keeping qualities of the fruit, it is considered the most profitable apple for this section.

Hall. Tree small but productive. Fruit small, oblate. Skin smooth, thick. Color greenish yellow covered and shaded with crimson and covered with russet dots. Flesh yellowish, fine grained, with a rich, mild, subacid, aromatic flavor. Good keeper.

Nickajack. (Caroline, Red Pippin, Hubbard, Pound, Carolina Spice, Winter Horse, Missouri Red, and more than

twenty others.) Tree upright, spreading, hardy and productive. Fruit large, roundish, somewhat oblate and slightly inclined to conic. Color yellowish, striped, splashed and shaded with two shades of red. Flesh yellowish, compact, moderately tender and juicy; subacid.

Limbertwig. Tree hardy, spreading branches, somewhat drooping. Fruit medium, roundish, oblate, inclining to conical. Color greenish yellow, shaded and striped with dull crimson, sprinkled with light dots. Flesh whitish, not very tender, juicy, with a brisk, subacid flavor. Good keeper.

Shockley. Tree moderately vigorous, upright, bearing young and regularly; very productive. Fruit below medium, roundish, conical, pale yellow, overspread with red. Flesh firm, crisp and juicy. Medium flavor, sweet. Good keeper. One of the most profitable apples in this State.

Smith's Cider. (Penn. Cider, Smith's Fuller.) Tree a very vigorous but straggling grower. Spreading; productive. Fruit medium to large. Roundish, oblate, conical. Color yellow, shaded and striped, with red, sparsely covered with gray dots. Flesh whitish, tender, juicy, crisp, mild, subacid.

White Winter Pearmain. Tree spreading, hardy and thrifty; a regular and a good bearer. Fruit medium to large, roundish, oblong, conical. Skin pale yellow, with a slight blush on side next to the sun, thickly sprinkled with minute brown dots. Flesh yellowish, crisp, juicy, very pleasant, subacid. Very good.

Romanite. (Southern Romanite.) Tree vigorous, spreading, very productive. Fruit small, roundish, conical, truncated. Color yellow ground, mostly overspread with clear, light, handsome red, with indistinct light dots. Flesh yellowish, fine grained, juicy, mild, pleasant, subacid. Good. Good keeper.

Arkansas Seedling Apples.

There are many valuable seedling apples in the State that have not as yet been propagated and introduced and as many of them possess great merit, work has been begun to collect them for description, classification and for trial. The work of description and making cuts was begun at the Arkansas Horticultural exhibit at the World's Fair, where there were exhibited nearly one hundred varieties that were not named. Cuts and descriptions of sixty of them were made and all the information that was possible regarding their history and habits, was obtained.

The description and history of these varieties will be published from time to time, and the best ones will be tested, both here and at the Branch Stations, and reported on in due time.

It is desired that fruit growers having meritorious seedling apples will send us specimens of the fruit, with the history and full information as to growth of tree and habits, etc., that we may increase the list and test all that are of value.

Purchasing Nursery Stock.

A number of letters have been received the past year complaining that fruits purchased from traveling nursery agents have proven in many cases untrue to name, unsuited to the locality, and in other respects not as represented.

It is advisable for many reasons to purchase nursery stock direct from some reliable nursery. The agent's commission can thus be saved, the stock is more liable to be true to name, which is a very important point, and is generally in better condition on arrival, as it is shipped direct from the nursery to the purchaser.

It is better to purchase from a nursery near home than from abroad as the stock is more likely to be suited to the locality and is not so long in transit. Purchasing new and

untried fruits is to be avoided. It is safer to purchase those varieties that have been tried and are known to be a success in the particular locality where they are to be grown. Before purchasing it is usually advisable to write to nurseries for their catalogues and price lists, or, if possible, visit the nursery. Care should be taken that the young trees are free from insects and disease.

One or two-year old trees are preferable to older stock.

Those contemplating the planting of large orchards will be cheerfully aided by the Station in selecting varieties suited to their section.

In answer to the many letters of inquiry regarding the purchasing of nursery stock, the addresses of the following lists of nurserymen who have sent us price lists and catalogues, are given:

Springdale Nursery, Springdale, Washington County.

Austin Nurseries—Geo. P. Murrell, Austin, Lonoke County.

Harrison Nursery—G. A. Gamble, Harrison, Boone County.

Rosdale Nurseries—F. L. Doubrava, Judsonia, White County.

Fort Smith Nursery—William Stromberg, Fort Smith.

Fourche Island Nurseries—B. B. Rogers, Little Rock.

Tipton Nursery Company—W. K. Tipton, Little Rock.

D. Wing & Bro., Rogers, Benton County.

Alvin Dickinson, Bentonville, Benton County.

James J. Britt & Bros., Bentonville.

Edward C. Horn, Latham, Van Buren County.

L. P. Davis, Lowell, Benton County.

Hartfield & Taylor, Fort Smith.

This Station will be glad to have communications from other nurserymen in this State so that their names may be added to a future list of Arkansas nurseries.

Olden Nursery Company—W. A. George, Olden, Mo.

Holt County Nurseries—N. F. Murray & Sons, Oregon, Missouri.

Sarcoxie Nurseries—James B. Wild & Bros., Sarcoxie, Mo.

Nelson Nursery Company—A. Nelson, Lebanon, Mo.

Stark Brothers Nursery and Orchard Company, Louisiana, Mo.

G. W. Gilbert, Thayer, Mo.

Bushberg Grape Nurseries—Bush & Son & Meisner, Bushberg, Mo.

T. V. Munson Nurseries, Denison, Texas.

Pilot Point Nurseries—J. W. Austin, Pilot Point, Texas.

Dallas Nursery Company—J. M. Howell, Dallas, Texas.

J. R. Johnson's Nurseries, Dallas, Texas.

Tyler Nurseries—Whittaker & Bailey, Tyler, Texas.

Sherman Nurseries—John S. Kerr, Sherman, Texas.

Evergreen Nurserses—G. A. McKee, Mt. Selman, Texas.

H. M. Stringfellow, Hitchcock, Texas.

W. H. Cassell, Canton, Miss.

Atlanta Nurseries—W. D. Beattie, Atlanta, Ga.

STRAWBERRIES.

W. F. Allen, Jr., Salisbury, Maryland.

Cleveland Nursery Company, Rio Vista, Virginia.

The Station solicits the co-operation of the people of the State in investigating fungus diseases and insects attacking fruits.

Whenever either are found doing damage it would be a favor if parts of the plant affected by the disease be sent, also insects, with full information regarding them. All such communications will receive prompt attention and the best known remedies will be recommended. When sending insects they should be enclosed in a tight box with a supply of the plant they are attacking.

JOHN T. STINSON,
Horticulturist.

Date.	APRIL. Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.	MAY. Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.	JUNE. Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.
1	.12	69	53	61	Fair.	....	58	43	50	Clear.	....	74	57	65	Cloudy.
2	.....	74	48	61	"	....	66	43	54	"	.05	76	56	66	"
3	.....	77	60	68	"	....	74	41	57	"	.75	83	61	72	Clear.
4	.....	89	55	72	"	.....	76	54	65	"	.....	83	61	72	Cloudy.
5	....	90	64	77	"	.....	76	60	68	Cloudy.	.67	76	60	68	Clear.
6	.....	87	68	77	"	.94	76	58	67	"	.....	74	52	63	"
7	.....	87	68	77	Cloudy.	.03	69	54	61	"	.....	79	50	62	"
8	.....	79	61	70	"	.10	63	55	59	"	....	80	53	66	"
9	.72	71	51	61	"	.....	78	43	60	Clear.	.....	84	53	71	"
10	.58	70	54	62	"	.....	80	58	69	Fair.	....	88	65	76	"
11	.60	77	62	69	"	.67	74	63	65	Cloudy.	.....	89	66	77	Cloudy.
12	1.58	76	54	65	Clear.	.....	79	50	63	Clear.	.....	87	64	75	Fair.
13	.80	79	52	65	Cloudy.	.....	79	55	67	Cloudy.	.....	87	59	78	Clear.
14	.....	62	33	42	Clear.	.33	69	61	65	"	.05	88	63	75	Cloudy.
15	.....	65	30	42	"	.05	77	60	68	Fair.	.....	86	60	73	"
16	.....	72	44	58	Fair.	.....	68	46	57	Clear.	.02	84	64	74	"
17	.....	75	45	60	"	.....	74	47	60	"	.....	87	62	74	"
18	...	72	53	62	Cloudy.	.....	78	47	62	"	.....	85	62	73	"
19	.55	71	36	53	"	....	84	63	73	"	.05	83	64	73	"
20	.05	59	36	46	Fair.	.....	85	63	74	"	.....	87	64	75	Clear.
21	....	56	36	46	"	.....	79	61	70	"	.....	89	69	79	"
22	....	63	39	40	Clear.	.70	77	64	70	Fair.	1.15	78	64	71	Fair.
23	...	71	33	52	Fair.	.....	69	44	56	Clear.	.....	83	60	71	Clear.
24	....	72	54	63	Cloudy.	.....	77	46	61	"	.....	89	70	79	"
25	.68	72	57	64	"	.....	82	63	72	Cloudy.	.....	94	69	81	"
26	1.05	68	52	60	Clear.	.63	79	67	73	"	2.75	91	63	77	"
27	.....	75	41	58	Fair.	1.80	69	53	61	"	.05	76	64	70	Fair.
28	.....	82	58	70	"	.74	63	55	59	Fair.	1.80	82	63	72	"
29	....	75	58	66	Cloudy.	.....	79	48	63	Clear.	.10	83	64	73	Clear.
30	5.00	64	50	57	"	.22	79	46	62	Cloudy.	1.40	86	63	74	Fair.
31	.....	.....	.....	.....	.....	4.75	74	56	65	"	.....	.....	.....	.....	.....

	JULY.					AUGUST.					SEPTEMBER.				
Date.	Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.	Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.	Precipitation.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Character of Day.
1	.....	83	64	73	Fair.	.....	85	59	70	Fair.	.....	81	50	65	Clear.
2	.15	82	65	73	"	.....	84	60	72	Cloudy.	....	80	55	65	"
3	.....	87	64	75	Clear.	.08	76	66	71	"	.....	90	55	72	"
4	.....	89	68	79	"	.....	84	62	73	Clear.	....	87	54	70	"
5	.....	89	71	80	"	.....	89	60	74	Fair.	.....	91	64	77	"
6	.....	88	70	79	"	....	91	61	71	"	.....	89	58	73	"
7	.....	87	67	77	"	.....	93	65	79	"	.....	86	61	73	"
8	.....	90	71	80	Fair.	.....	93	63	78	"	.....	84	55	64	"
9	.58	84	67	75	Cloudy.	.....	93	64	78	"	.....	80	52	66	Fair.
10	....	83	64	73	Clear.	.....	90	66	78	Cloudy.	.04	89	61	75	Clear.
11	.....	86	62	74	"	2.35	82	66	74	"	.01	81	55	68	"
12	.....	89	68	79	"	.....	80	61	70	Clear.	....	87	64	75	"
13	.....	88	69	78	Fair.	.....	86	59	77	"	.....	100	68	84	"
14	.....	90	70	80	Clear.	.....	88	62	75	"	.....	100	75	87	"
15	....	91	72	81	Fair.	.....	89	64	76	"	....	98	70	84	"
16	.....	89	65	77	"	.....	90	61	78	Fair.	.....	84	59	71	"
17	.....	85	65	75	Cloudy.	2.20	87	64	75	Cloudy.	.....	94	60	77	"
18	3.85	80	65	72	"	.12	87	66	76	Clear.	.....	95	71	83	"
19	.....	81	64	72	"	.....	88	66	77	Fair.	.....	94	64	79	"
20	.....	81	63	72	Clear.	.....	88	66	77	Clear.	.....	93	60	76	"
21	.....	85	60	72	Fair.	.....	86	58	72	"	.....	95	69	82	"
22	.....	87	63	75	Clear.	.....	84	54	69	"	.....	92	70	81	Cloudy.
23	.....	89	63	76	Fair.	.15	79	64	71	Fair.	.26	84	68	76	"
24	.....	86	64	75	"	.50	87	62	74	"	.65	73	63	68	"
25	.....	89	71	75	"	.....	86	61	73	Clear.	1.25	70	49	59	Fair.
26	.....	93	68	80	"	.....	85	61	73	"	.....	71	39	55	"
27	.....	92	68	80	"	.40	87	62	74	Fair.	....	76	51	63	Clear.
28	.....	96	70	83	Clear.	.....	74	58	66	Clear.	.....	79	59	69	Cloudy.
29	.....	94	69	81	"	.....	73	49	62	"	.....	77	61	69	"
30	.....	96	70	83	Fair.	.....	76	48	62	"	.87	86	65	75	Clear.
31	.....	90	70	80	"	.....	77	49	63	"	.....	.....	....	.....	.....

Late Crops for Overflow Lands.

A number of experiments were made last year on overflowed lands on White River at Newport, with various crops to determine their adaptability and profitableness for late planting on such lands.

Large areas of fertile lands in the eastern and southern parts of the State are overflowed more or less in the spring of every year by the creeks and rivers that flow through them. These lands are of two kinds, those that overflow only in extreme high water and those that are lower than the first and are overflowed at various stages of high water during late winter and spring. This latter class of lands is not usually cultivated though the lands are very fertile and when dry are adapted to cultivation. The first class of overflow or high bottom lands are cultivated in the staple crops. The overflows do not occur annually, but when they do they damage either by delaying planting or by killing out the crops that have been planted. These are usually cotton or late maturing corn. Frequently the season is too far advanced to replant the first crops when they have been drowned out, then the lands remain idle until next spring if not replanted in corn. The replanting is usually done between June 15th and July 1st, and the planting of crops on the very low lands is also done about those dates. The lands are not sufficiently dry earlier than that and all danger from overflows does not pass until then, so the date of planting or replanting makes the growing season very short, and limits the kinds of crops that can be grown, and limits them chiefly to the nature of plants or products for stock feed.

The land selected for the experiment was low, first bottom land on White River that overflows annually. It had been cleared of the wood but had never been plowed and when broken was rough and unsatisfactory.

An effort was made to secure more suitable land in cultivation on the St. Francis River but none could be secured where proper attention could have been given the crops. The deposit on the experiment land from the overflows during the previous winter was an average of three inches. The soil was dry for plowing about June 20th but plowing was not begun until July 1st; then the soil was dry with a drouth prevailing which continued until July 19th. The new soil made such an imperfect and unsatisfactory seed bed that the ill effects of it on the crops were manifest throughout their growth. After planting few seed germinated until rain came July 19th. The cloddy seed bed had dried out below the seeds so the delay in germination virtually amounted to having planted them the middle of July instead of the first. The young plants suffered little or no damage from insects, neither was trouble caused by crab grass though a weed commonly called "Coffee" weed caused considerable trouble in cultivation.

Planting.—The soil was broken, harrowed and rolled, and prepared according to the common practice for each variety of crop, but the seed beds were rough and cloddy owing to the soil being dry and fresh. The seeds were planted July 1st, each on one-tenth acre of land.

Millet, German.—Sown thick and a fair stand secured though not enough for the soil. It grew rapidly after the first rain, July 19th, and began heading August 7th; was cut when in full bloom August 19th; height, four feet; weighed October 9th when thoroughly dry and yielded per acre 3,428 pounds of excellent hay. The imperfect stand and "Coffee" weed reduced the yield. Such fertile soils are especially adapted to millet and require thick seeding to prevent coarse straw.

Oats, Black Russian.—The seed germinated but the soil was so cloddy and dry that all the young plants died before rain came. The oats were planted for hay.

Beans, White Dwarf Navy.—Planted in a continuous drill in three feet rows and cultivated shallow twice; second cultivation was done with long scrape one furrow to the row. They grew rapidly and were gathered September 19th. Yield per acre of shelled beans 950 pounds with a loss of about 5 per cent in hand shelling. Beans can be picked and shelled by hand for home use but for market, machinery should be employed. Beans are a staple product and sell readily and usually for good prices.

Sweet Potatoes.—The lack of rain until July 19th was disastrous to the potato. They made little growth until August 15th; after that they made a good growth of vines but only few tubers. The rough soil would doubtless have prevented a large yield even if rain had fallen earlier. On smooth soil the sweet potato would make a very profitable late crop for market and especially a good crop for hogs. Few crops are superior to the sweet potato for fattening hogs, and utilized in that way there is no cost of gathering as the hogs will gather them for themselves.

Cowpeas, Whipporwill.—Two plats were planted; rows of one plat were three feet, those of the other plat were sixteen inches, which was too narrow and yielded inferior to the three feet rows. Peas grew rapidly and rank and were suitable for hay September 20th. Pods were long and well filled; 75 per cent were ripe October 9th, 10 per cent unripe pods at frost. Yield per acre of peas in hulls 758.3 pounds. The vines were coarse, difficult to cure and made only fair hay. Whipporwill and other bunch varieties are best for hay and peas on such rich soil. Rows should not be less than three feet apart.

Buckwheat, Japanese.—Seed was sown thick in rows for cultivation to keep down weeds. The stand was good, cultivated twice, one furrow to the row with long scrape; it grew rapidly and luxuriantly and began blooming August

1st; height, three feet August 15th; grew so rank that it fell down badly. The yield of seed was not estimated. Buckwheat is grown mainly for the grain for making flour and is cut and threshed by machinery.

Corn.—Several varieties of early, medium and late maturing varieties were planted to determine those that would produce the largest yield and mature before frost. All varieties were planted thick in a continuous drill and were to have been thinned to a stand suited to each variety's growth, whether large or small, but the drouth killed out the young corn so badly that all were about equal in stand. Rows were three and one-half feet apart and plants eighteen inches apart in the drill. September 8th a severe wind and rain blew the corn down and entangled it very badly. Its growth was extremely rapid from July 19th, the date of the first rainfall after planting. The varieties are described in the order of their maturity. Total yield includes good ears and nubbins.

Pride of the North.—Very early corn, tasseled August 9th, ears small, length five to six inches, small yellow grains, damaged by early drouth because of its earliness; the ears were badly worm-eaten; very unsatisfactory corn. Total yield per acre 39.42 bushels.

Leaming Yellow.—Medium maturing corn, ears six to eight inches long, grains small and roundish, well filled from end to end of the cob, extremely little worm-eaten, cobs perfectly dry when gathered, 90 per cent good sound ears, grains small, otherwise entirely satisfactory Total yield per acre 55.8 bushels.

Golden Beauty.—Medium maturing; matured rapidly after October 4th when it was in dough; ears five to eight inches long, grains broad, medium length and thickness, cob filled from end to end and ears perfectly mature; cob thoroughly dry when gathered, extremely little worm-eaten,

90 per cent good sound ears; grains superior to Leaming though smaller cob; soundest of all the varieties. Total yield per acre 51.3 bushels.

Mastodon Dent.—Medium late maturing; ears medium size, six to nine inches long; grains thick, short and yellow; 50 per cent good mature ears; not a satisfactory variety. Total yield per acre 53.1 bushels.

White Giant Normandy.—Late maturing; very large long ears, large cob, broad, flat, white dent grains; 50 per cent mature sound ears, little worm-eaten; not suitable for planting as late as July, the large cob dries slowly. If planted on smooth soil June 15th it would mature and yield abundantly. One of the best varieties for early planting. Total yield per acre 59.4 bushels.

Corn Forage.—Leaming yellow corn was cut when the grains were beginning to glaze and was weighed when perfectly dry in January. Yield per acre 9,872 pounds. The stalks of this variety are small and they make an excellent forage. Corn grown for forage or ensilage should be planted sufficient distance to allow a good growth of ears, and the best stage to cut to secure the most dry matter is when the grains have glazed or dented in dent varieties or when nearly ripe.

REMARKS.—All the early maturing corns matured perfectly before frost, but the need of moisture for nineteen days after planting, together with the fresh and cloddy condition of the soil, delayed the late maturing varieties so much that they did not mature perfectly before frost. If these conditions had been less severe, or if the late maturing corns had been planted June 20th when the water was off the land, all would have matured. Mr. L. Minor, of Newport, planted corn July 6th to July 12th on lowlands that matured perfectly. His soil though was not fresh, having been in cultivation for three years, and his planting was followed by a

rain July 19th. The experiment corn was planted six to twelve days earlier, and a large per cent that came up before the rain July 19th died, so the two plantings were practically done at the same time. The young corn in the experiment dying for the want of moisture shows the very unfavorable conditions of the soil and weather up to July 19th.

The medium and late maturing corns were little worm-eaten, the Golden Beauty less than any. Other insects did no damage to any of the crops. Grasshoppers however ate the leaves off the beans, but at that date the beans had ceased growing and were gathered a few days later. At the time the grasshoppers appeared most other vegetation was too hard for them so they congregated on the beans, but they were too few in number for their damage to have been noticeable on a large area. The first killing frost occurred October 15th. The yields and successes of the various crops are very satisfactory and few farmers will ever have more unfavorable conditions for growing late crops than those that affected these experiment crops. The rough fresh soil, drouth at planting and for nineteen days thereafter, and noxious weed growth all operated in delaying maturity and in reducing the yields.

REVIEW.—Golden Beauty corn was the soundest corn of the lot, next was the Leaming. Giant Normandy, if planted not later than June 15th on land previously cultivated, would mature before frost and would doubtless be the heaviest yielder.

Husks prevent a rapid drying of the corn and cob and should be removed from late planted corn when the corn is gathered for housing. If the corn planted is a late large cob variety the cob will contain much moisture.

While Golden Beauty and Leaming and probably other varieties not tested will mature before frost when planted as late as July 15th, it is advisable to plant earlier when possible.

Few soils are too wet to plow as late as July 1st while a majority can be plowed earlier.

Late corn grown on lowlands should be carefully selected and all decayed and worm-eaten and otherwise damaged grains removed before being fed to horses. This is very important.

Late crops for lowlands should be planted just as soon as dry enough to plow and all danger from overflow has passed, so that the seed may come up and get rooted before the moisture dries out of the surface soil. The plants will then begin growing even if rains do not come for several days after planting. Lowlands usually contain an abundance of moisture a few inches below the surface and plants well rooted are not likely to suffer from drouth. Lowlands plowed before too dry will not break in clods.

It is important to use seed liberally in planting late crops as replanting cannot be done if necessary, and besides, the lowlands are usually fertile enough to bear thick seeding. Little cultivation is required for late crops as the season is far advanced when they are planted and the rapid growth shades out most noxious vegetation. Cultivation should be shallów and a scrape and scooter used together is one of the best implements for that purpose.

From the success and yields of the various crops and their cost of production it appears that ordinarily, millet and corn are the most profitable ones to grow on the overflow lands. Millet is a heavy yielder and does not grow coarse stems when sown thick and should be cut when in bloom to make the best hay. The fertile lowlands are well adapted to millet. The Golden Beauty corn is the best of the varieties for very late planting. It should be planted thick as the stalks are small. Champion Early White Pearl matures about the same time as the Golden Beauty and for white corn it would be an excellent variety to plant. Corn forage of

fine quality was successfully made and would be profitable. Beans would also prove a profitable crop. The profitableness of the various crops will depend upon the grower's facilities for disposing of them or for utilizing them on the farm.

Profitable Utilization of the Crops.—As previously stated the conditions of season, market, etc., restrict the crops that can be grown mainly to such as are used for animal feeding, and as animal foods they can be disposed of by selling them or by converting them into beef and pork for market or for home consumption. It might be suggested that the highlands that overflow only occasionally in extreme high water and when the overflows occur too late to allow replanting of the first crops when killed, could be planted in late crops for stock feed. If the local market demands were too limited for disposing of the products, as they would likely be if many planters grew stock feed on the overflowed lands, the products could be either shipped to other markets or be converted into beef and pork on the farm and shipped to large markets. Lean steers, two and one-half years old or over, could be bought if not already on the farm and fed three or four months during winter until fat, then shipped for good prices. In that manner surplus products from overflowed lands could be disposed of readily at a profit. It appears advisable to plant very low lands that are wet until late spring from annual overflows in late crops for the production of stock feed for the stock kept constantly on the farm and to reserve all higher lands for such other crops as desired. Much lowland that now lies idle could be utilized in that way.

Grass.—Some perennial grasses will be put out for trial this year on lowlands subject to annual overflows. It is highly probable that some might be successfully sown for hay and for grazing. There are one or more perennial

grasses of which there is no doubt of their success on these soils for hay or for grazing for all kinds of stock, but there is a *serious objection to them*, in that they are liable to scatter to soils where they are not wanted. Johnson grass or Sorghum Halapense can be mentioned as one that would doubtless be most successful. Cattle constantly grazing it and hogs rooting for the roots of which they are very fond, will in time effectually exterminate it. When cut for hay when in bloom, which is the best time to cut to make the best hay, it cannot be scattered by animals eating it, and on the fertile lowlands it would yield annually from three to five tons of choice hay per acre.

For rainfall and weather conditions during this experiment see weather table on last page of the bulletin.

The following letter explains itself:

NEWPORT, ARK., March 19, 1894.

R. L. Bennett:

DEAR SIR—The following is the data of my late corn planted on overflow land: Soil, black loam, three years in cultivation. Water was off the land June 20th. Tennessee White Flint corn was planted July 6th to 12th and yielded about forty-five to fifty bushels of sound well matured corn per acre. Corn planted any time in June is fine, that planted in July should be shucked before housed as shuck prevents drying. Have shipped six cars this corn and have more orders than I can fill. Yours truly,

L. MINOR.

Varieties of Corn Adapted to Different Sections of the State.

Several varieties of corn that were known to possess some merit have been tested in the northwestern part of the State at Fayetteville and in the northeastern part at Newport, to determine those varieties of both early and late corn that

would be best for planting in all sections of the State. Several varieties were tested at Fayetteville during the years 1888, 1889 and 1890 and the results were reported in the annual reports for those years. At Newport several varieties were tested in 1892 and 1893 and their results are reported subsequently. Varieties of corn vary so much in yields in different years with respect to each other that one year's test is of little value, but from the yields of several tests together with the qualities of the varieties a few of the best ones can be selected and recommended for planting. In determining the value of a variety it is important to consider with the yields the date of maturity, height of stalk, shape and size of the ear, height of ear on the stalk, number of ears to the stalk, shape and size of the kernels and cobs. Farmers generally are aware that most early corns have smaller stalks and ears than late corns and that therefore the early corns or corn with small stalk should be planted thicker than the late ones or large stalked varieties. In testing several varieties of both early and late corn when planted according to their habits of growth, the weather influences frequently prevent a comparison of the yield of one kind with that of another. If a drouth should prevail at the time when one or the other was forming ears it would decrease the yield of one and not the other.

The varieties of both early and late corn planted at the northeast Station in 1892 were those that yielded the most in the tests previously made at Fayetteville. Different lots of seed grown by local planters were also planted to compare the merits of the corn grown in the vicinity of the Station with the pure varieties. The early and late varieties were not planted according to their habits of growth, but all alike and at the same time, and the cultivation too was the same for all. Checked three and a half by three and a half feet. The seed of the varieties were bought north of Arkansas and

they matured a few days earlier than the local varieties. The soil was sandy loam common in eastern and southern Arkansas.

Varieties.	Yield in Bushels per Acre.
Mammoth White (white)	39.69
Giant Normandy (white)	37.48
Champion Early White Pearl (white)	36.59
Blount's Prolific (white)	30.82
Big Buckeye (yellow)	29.10
Golden Beauty (yellow)	28.22
Piasa King (white)	27.33
FROM LOCAL PARTIES.	
L. Minor	35.71
Thos. Brown	33.51
J. W. Parish	29.98
M. L. Robinson	26.45

From the yields as well as the quality of the corn produced it is evident that two of the local lots tested could be profitably abandoned by the growers for other varieties. The early corns were planted too far apart to make their best yields. Mammoth White was tried at Fayetteville but one year, 1891, then it produced the second largest yield. Giant Normandy produced the largest, which it did each of the three years. Mammoth White has produced large yields elsewhere. At the Kansas Station it was the largest yielder of 140 varieties. The yields of the varieties at Newport with respect to each other are about in keeping with those at Fayetteville.

Tests in 1893.—As Giant Normandy had for three years yielded the most at Fayetteville, and there being little difference between its yield and that of Mammoth White at Newport, it was used to compare the yields of two varieties of late corn, Pride of America, and a Southern variety, Welborn's Conscience.

To determine a good early white variety Champion Early White Pearl was planted again as it had yielded well the previous year. All were planted and cultivated alike.

Varieties.	Yield in Bushels per Acre.
Giant Normandy	31.8
Pride of America (white)	29.2
Welborn's Conscience (white)	28.8
Champion Early White Pearl	27.4

A drouth that was prevailing at the time that the Champion Early White Pearl was forming ears may have reduced its yield, and also having a small stalk its yield would have been increased by thicker planting. The soil was not so fertile as that where the varieties grew the previous year. Those who desire to see in detail the tests at Fayetteville are referred to the first, second and third annual reports. From the tests at the two Stations the following varieties are recommended for planting in all sections of the State.

LATE MATURING VARIETIES.

Giant Normandy, Mammoth White, Pride of America.

MEDIUM MATURING VARIETIES.

Champion Early White Pearl, Golden Beauty, Leaming Yellow.

White Giant Normandy.—Large tall stalks, cob long and good size, kernels very broad, thick and long, ears borne on stalks at medium height.

Mammoth White.—Large stalks, cob good size, grains large, ears borne on stalk at medium height.

Pride of America.—Stalks very tall and large, cobs large and moderate length, grains long, medium width and thickness, ears medium height on stalks.

Champion Early White Pearl.—Stalks medium size, cob long and medium size, grains good length and thickness, ears low on stalks.

Golden Beauty.—Stalks medium size, cobs small and long, grains of medium length and thickness.

Leaming Yellow.—Medium stalks, cobs larger than Golden Beauty, but smaller and rounder grains, was grown with Golden Beauty on overflow lands at Newport.

These varieties as they grew in the experiment possessed excellent qualities, besides being good yielders; additional value is given them by their success in tests made elsewhere. The maintenance of the merits of a variety will depend very much upon careful growing and selection of seed. Seed corn should be selected in the field from the best stalks and ears.

Notes on the Cultivation of Corn.

In cultivating corn on the Experiment Station during several seasons, when the rainfall was different in each, I have observed that the manner of cultivation had much to do with the improvement of the corn. As the season advances and corn increases in growth, and moisture in the soil decreases, the effects of the different cultivations as well as the time of cultivating have been easily observed, but no effort has been made to determine from year to year the exact effect of deep and shallow culture. When the root growth of corn is considered it is clear that deep cultivation cannot be done without root pruning and the amount pruned will depend upon the depth of cultivation and the age of the corn. The essential thing in cultivating corn is to prevent weeds and grass from growing and to keep the surface soil in good tilth. To do that there is no need of deep culture. Deep culture is not often required after planting to rebreak the soil if it is well broken before planting, but when rebreaking is necessary it should be done not later than the first working. All subsequent cultivations should be *shallow* and *level*. This is especially important with cotton. It is damaged to a greater

extent by deep cultivation than corn, and when advanced in age deep cultivation during a drouth will amount almost to a disaster. While shallow culture does not disturb the roots it has the advantage of light draft on the team, and a plow can be used that will cut a greater width of surface than a deep plow, thus requiring a less number of furrows to the row and enabling more ground to be gone over per day.

Frequency of Cultivation depends mainly upon the rapidity of weed and grass growth and the condition of the surface soil, whether loose and porous or whether a crust has been formed by rain. Grass and weeds will start little growth in loose porous soil, but when the surface soil is run together by rain they are enabled to grow, and to keep them down the surface soil should be stirred again after the rain. Another and equally important advantage of surface stirring after a rain is that the continuity of the soil pores is broken and the inch or two of loose surface soil prevents to a large extent the evaporation of water from the soil below; the loose soil acting as a mulch in that respect. There is little, if any, good done corn advanced in growth by cultivating it when the soil is free from noxious vegetation and in a loose porous condition, while sometimes much harm is done when the cultivation is done deep and especially if a drouth is prevailing at the time as is frequently the case at the last working.

The Scrape and Scooter.—I have found them when used together to be one of the best implements for shallow cultivation of corn and cotton. They can be attached to a single stock or to a cultivator. The scrape can be made any length, and for all plowings after the first they are used from eighteen to twenty-four inches long, that is, they will cut that width of surface. The scrape should run level and is held steadily in the ground by the short scooter. The best work is done when the scrape is attached to the heel of the foot. They are

inexpensive, easily sharpened, of light draft and do the most effective work in cotton and corn. If the scrape is not found in all small markets it can be easily made in any blacksmith shop. A piece of steel about one quarter of an inch thick and about two and one-half inches wide and cut to any length desired is sufficient. One edge is sharpened, a hole made in the middle for the heel bolt and from about one to one and a half inches on each side of the center of the hole bend the two ends back to an angle between 30 and 35 degrees. The cutting edge should be made so that when placed upon a level surface all parts of it will touch the surface. The top edge is then inclined backward so as to place the lower cutting edge in a cutting position. In this shape the scrape easily cuts all tap rooted vegetation and at the same time lifts the soil allowing it to fall over behind the scrape in a thoroughly pulverized condition. By the use of a long scrape when corn and cotton are advanced in growth cultivation can be done close to the stalks without breaking the limbs and the short scooter is far enough off so as not to disturb any large roots. With it two furrows will thoroughly cultivate each middle, leaving no ridge of soil but instead a level surface. The scrape is so effective in its work that when used a greater part of the costly and unbeneficial hoeing is dispensed with.

Time of planting and distance of planting corn depends upon the conditions and local surroundings. The distance of planting is governed mainly by the variety, climate, and soil fertility.

Rotation of Crops to Maintain and Restore Fertility to Worn Soils.

The fourth year of the rotation furnishes the following results:

Plat 1.—Continuous cotton culture.

Yield of seed cotton at different pickings	Sept. 18th,	5 15-32	lbs.
" " " " " " "	Oct. 7th,	19 8-32	"
" " " " " " "	Oct. 30th,	12 8-32	"
" " " " " " "	Nov. 25th,	4 27-32	"
Total yield of that area, 1-10 acre		41 13-16	"
Total yield per acre		419 1-8	

Plat 3.—Corn and peas previous year, 1892.

Yield seed cotton at different pickings	Sept. 18th,	22 16-32	lbs.
" " " " " "	Oct. 7th,	36 8-32	"
" " " " " "	Oct. 30th,	13 22-32	"
" " " " " "	Nov. 25th,	2 28-32	"
Total yield of that area, 1-10 acre		75 5-16	"
Yield per acre		753 1-8	"

Plat 2.—Oats followed by peas 1892, oats planted October 28, 1892, cold reduced stand 15 per cent, cut June 7th for hay.

Yield oat hay, perfectly dry	300	pounds.
Yield per acre	3,000	"
Peas followed oats spring 1893 yield shelled peas	1 1-5	bushels.
Yield per acre shelled peas	12	"

The subjoined table is exhibited for comparison of the yields of each plat for each year.

FIRST YEAR.

NO. PLATS.	PLANTS AND METHODS OF TREATMENT.	YIELDS PER ACRE.
1	Seed cotton	830 lbs.
2	Field peas; peas picked (Pea vines turned under and barley sown in fall).	33⅓ bu.
3	Field peas; peas picked (Pea vines allowed to remain on soil).	33⅓ "

SECOND YEAR.

1	Seed cotton	700 lbs.
2	Barley; cut hay 1,500 pounds (planted in cotton and omitted because of error in picking).	
3	Seed cotton	950 "

THIRD YEAR.—(Bad Season).

1	Seed cotton (only ⅔ stand)	431⅞ lbs.
2	Peas; peas picked	17½ bu.
3	Corn	22 2-5"
	Peas in corn; peas picked	6⅔ "

FOURTH YEAR.

1	Seed cotton	419⅛ lbs.
2	Oat hay	3000 "
	Shelled peas	12 bu.
3	Seed cotton	753⅛ lbs.

The value of the products of each plat for each year can be calculated by any one that desires to do so. The value of the rotation can be better seen when such a calculation is made. There was a remarkable difference in the size and appearance of the cotton on plats 1 and 3 this year, likewise between the yields of seed cotton. While the stand of cotton on plat 1 was not so good as that of plat 3 a perfect stand would have increased the yield but very little.

The imperfect stand was not due to imperfect seed as the seed all germinated but many died after coming up. The young plants lacked the vigor that characterized those on plat 3 and their growth too at first was slow and hesitating, making cultivation difficult and costly, as the hoe was often required. The young plants on plat 3 grew rapidly from the start. *The imperfect stand and the weak young plants show the importance of rotation over continuous cotton culture.* By calculating the cost and value of each plat's products it will be seen that no loss has occurred by growing other crops than cotton and that the soil has been maintained in fertility.

The difference, however, of 76 15-16 pounds of seed cotton between the yields of plat 3 this year and that of plat 1 the first year tends to show that the soil has not been maintained in fertility. I attribute that small difference in yield per acre to the removal of the valuable fertilizing constituents in the 633 pounds of cotton seed from plat 3, which it produced the second year and to that removed from it the third year in the 22 2-5 bushels of corn and in the 6⅔ bushels of peas. Those fertilizer constituents were not returned to the plat in the limited amount of pea vines produced in the corn and the cornstalks left on the soil the third year. The weather influences to which the cotton plant is very susceptible may have been more favorable the first year than they were the fourth year.

Since the results of the rotation thus far have been of value the plan of rotation has been enlarged and a different succession of crops will be made.

The Effect of Cultivating Cotton During Dry Weather when the Surface Soil is Free of Grass and in a Loose, Porous Condition.

At the time of the cultivation, July 11th, the surface soil was free of grass and weeds and was loose and porous. The last cultivation had been done twenty days previous and immediately after the last rain. Several rows were selected near the middle of the field and cultivated shallow with scooter and scrape, simply stirring the surface as in the regular cultivations. After that no rain fell for eight days, making a period of twenty-eight days without sufficient rainfall to settle the surface soil. The cultivated rows were carefully observed, but they showed no improvement whatever over adjoining rows uncultivated. It should be observed that at the date of cultivating the rows the cotton was at an advanced age when it is readily affected by influences. No

attempt was made to determine what the effect would have been at this time by deep cultivation as the amount of damage would have depended on the depth of cultivation and upon the quantity of roots pruned. *From the experiment, it appears advisable to delay the cultivation of cotton during drouth until a growth of grass or until a sufficient rainfall requires it.*

The Cultivation of Cotton.—The remarks made on the cultivation of corn as well as those on the scrape and scooter on the foregoing pages are entirely applicable to cotton.

Two Varieties of Egyptian Cotton.

A considerable quantity of this cotton is imported to this country. It has long staple but is inferior to American long staple, and costs less. The seeds of the two varieties Bamiah and Afifi were received by the Station in March from the Agricultural Department at Washington and were planted on the Station and three neighboring farms. It was not intended to publish the results until another year's experiments had been made with the varieties but several requests were made for information of them so it was finally decided to publish the experiments this year.

On two farms the varieties were a failure making only a few bolls but a large weed growth. The soil was low, rich loam.

On the Station on dry, sandy loam soil, without fertilizers, Bamiah yielded per acre of seed cotton 300 pounds. Afifi yielded per acre of seed cotton 200 pounds; native cotton (Peerless) alongside, 740 pounds.

On the third farm where the soil was similar to the Station, except that it was on a slight hill with eastern exposure and that a crop of pea vines was turned under, Bamiah

yielded per acre of seed cotton 856 pounds. Afifi yielded less. This soil was warm in spring, well drained and in good tilth.

Character of Growth.—BAMIAH—One upright stalk, no long limbs, each boll supported by a stem that grew from the main stalk, leaves large, bolls pointed, medium size, fruited regularly and well from ground up. Its upright growth would allow thick planting. First bolls open September 11th.

AFIFI—Stalk full of long limbs, not well fruited, bolls very pointed and smaller than Bamiah; first open boll September 19th.

Both varieties were very slow to begin growth in spring; little growth was made until hot weather, July 20th; drouth had no apparent effect on either variety; stalks of both varieties grew tall; two-thirds of the bolls on the varieties opened after frost killed the leaves. The small, pointed bolls made picking very difficult; three locks to the boll; lint loosely attached to seed. Bamiah is superior in yield, character of growth and earliness.

The per cent of lint of seed cotton:

Bamiah, lint 32.38
Afifi, lint 35.3
Bamiah, seed 67.62
Afifi, seed 64.7

The Bamiah lint is more loosely attached to its seed than Afifi lint is to its seed.

This year's trials show the varieties to be unprofitable in this State.

It was intended to publish herewith an expert's report on the value of the lint, but the report has been unavoidably delayed and will therefore be published in a subsequent bulletin.

Stack-Frame for Curing and Storing Cowpea Hay.

Notwithstanding the recognized value of the cowpea for hay the difficulty of curing the vines has prevented somewhat its extensive cultivation for that purpose.

As a hay plant for the eastern and southern parts of the State it is of special importance particularly on the unfertile and sandy soils of those sections where grasses and clovers will not grow profitably for hay. Pea vines cured for hay in the field require several days of sunlight to cure them sufficiently to keep when stored and the length of exposure in the field frequently subjects the hay to rains which is very damaging as the vines will not turn water even when raked into piles. The sun hardens the vines and the mature pods dry and fall off in handling. Dews damage the hay also, but the most important loss in field curing occurs in the leaves. They are the best part of the hay except the peas, and as soon as dry, which is long before the vines are dry, a greater part drop off. The hay when cured after long exposure to the sun and dews is not so palatable to live stock as it is when cured in the shade. It is apparent to every one that if some method was provided that would be inexpensive and effectual in avoiding these difficulties and losses a great advantage would be gained. A method for curing after storing would suggest itself as being the most desirable and if efficient it would avoid all losses from field curing. Last season we undertook to devise a stack-frame that would be inexpensive, permanent and efficient in curing and preserving the vines when stored in it in a green state. The subjoined cut exhibits the frame that was erected.

STACK-FRAME FOR CURING AND STORING COWPEA HAY.

The frame differs materially in many important points and possesses superior advantages to any stack-frame or other contrivance used for curing and storing pea hay that I am acquainted with, and I am unaware that any frame has been previously built essentially like it; but if there has, a published description of it will be useful to many in this State. From the cut it can be seen that the frame is simple in construction, is built of round poles, rails, planks for horizontal supports and strips for braces. The hay stored in it cured and preserved perfectly and retained a greenish color and was eaten greedily by cattle and horses.

Experiment Hay.—The frame was erected at the time that the peas were ready to cut for hay. The vines were cut in the morning after the dew was off and allowed to remain on the ground to wilt until the next morning, when they were raked with a horse rake, hauled on a two-horse wagon to the stack-frame and stacked in the manner shown in the cut. Straw was then thrown smoothly over the top to turn off rain.

No leaves or pods were lost during handling, as the vines and leaves were only slightly wilted, and if a rain had fallen on the hay before it was stacked no damage would have been done to it. The hay was cured entirely in the shade and retained a bright, greenish color, a quality that is desired in hay.

It remained in the stack until January, when it was removed and found to be in perfect condition.

Construction.—The plan of construction is a series of open shelves arranged one above the other. The shelves are made of rails placed twelve inches apart with their ends resting on horizontal supports. The supports are nailed two feet apart to upright posts put with one end securely in the ground. Strips one by four with one end resting on the ground are nailed diagonally to the horizontal supports for braces. They are essential to prevent the frame from inclining, for supporting and holding in place the ends of the horizontal pieces.

The length of the stack-frame can be increased indefinitely by erecting frames similar to the one shown in the front end of the stack and distant from each other the length of a fence rail or whatever is used. These cross frames can be made on the ground and then set in place. The sides of the stack are and must be perpendicular since pea vines will not turn water. To give the top the proper pitch to turn water the top shelf is made narrower than the shelf below by leaving out the side rails as shown in the cut. Sufficient straw or grass hay should be used for covering and it must be made to project over the edges of the first wide top shelf so as to turn all water off the sides of the frame. The dimensions are as follows:

Width ten feet, made so because the plank used were already cut that length.

Length three fence rails, each fence rail eleven feet.

Shelves or floors two feet apart.

Rails placed twelve inches apart on the horizontal supports.

Capacity four tons dry hay; five tons if covered with tarpaulin.

The width of the stack can be increased but if made very much wider the straw cover would not be sufficient to turn rains. The height can be increased until inconvenient to put hay on the top floor. It would doubtless be cheaper and better to use stout, dry poles of greater length than rails, the frame would be sufficiently strong and a less number of cross frames would be required. Small rails or poles would be better to use than large ones as they would occupy less space. It should be observed that free ventilation is allowed in all directions. The cut shows so completely the plan of construction that detailed instructions for erecting are not necessary. The cost is very small—two ordinary farm hands can get the material and erect in two days, and it will last for use many years, as no part is exposed to decay except the ends of the posts in the ground and the outsides of the two ends. If tarpaulin be used to cover with, a ton or more of hay can be stacked and saved where the straw cover is lost. More storage space would be made as less pitch would be required for the roof and the frame itself could be made wider. Tarpaulin would be more than paid for the first year in the hay saved, and it would last many years. Duck weighing ten ounces and forty inches wide will cost about 20 cents per yard. A permanent roof of boards could be used to cover the frame and in that case instead of using the diagonal braces posts similar to the middle posts could be used and the ends of the horizontal supports nailed to them. The middle line of posts could be taller than those on the sides to support the comb of the roof while the eaves would be supported by the lower outside posts.

Stacking Hay.—To put the hay in the frame all the rails or shelves are out, leaving standing simply the cross-frames. The first floor of rails at the ground are put about twelve inches apart on the horizontal supports. The wagon of hay is then driven alongside and one man unloads the hay on the floor while another places it. When the hay has been put evenly on until it is a few inches above the place for the next floor the rails or poles of the second floor are put in place. They press down the hay beneath but as it dries it settles leaving a space above. Hay is then put on this floor as on the first and so on with each floor until the top is reached; then the cover of straw or tarpaulin is put on. If covered with boards, hay can be put on the last shelf under the roof by putting first a few rails in the middle of the supports and then hay on these. More rails being added to the sides of the first ones with hay put on top until the outsides are reached.

Removing the Hay.—To remove the hay as desired for feeding, it is taken first from the lower floors and then from those above until the top is reached. The cover being the last removed protects the hay until all of it has been taken out. Beginning on one side of one section the hay can be drawn out of the sides of the two first floors and the rails or poles removed from those floors as they become in the way; the same is done with all the floors. To remove all the hay at once work should begin at the top of the stack.

Review.—1. The stack-frame was a perfect success and will be permanently used on the Station.

2. By the perfect and thorough ventilation allowed, hay cannot injure in curing, therefore such a stack-frame makes the question of curing pea hay a very simple one.

3. The hay cured in the frame was examined by many farmers and pronounced by them to be as fine as they ever saw.

4. The vines should be stacked as soon as wilted; if cut in the morning and exposed to the sunlight they can be stacked that evening. By stacking the vines when wilted no loss whatever occurs and the best possible hay is made.

5. A very important advantage can be gained by the use of the frame in that hay can be made independently of the weather. It would be advisable to have such a stack-frame on every farm where other hay is made, for in the event of rainy weather at hay making the hay could be cured and saved notwithstanding the unfavorable weather.

6. Cowpea hay is bulky and much barn room can be saved by curing and storing in the frame or by curing in the frame then baling the hay or stacking it around a pole.

7. By having the pea crop ready to cut at different dates and by the use of the stack-frame pea hay could be grown extensively and baled for a market crop.

8. The frame possesses advantages of requiring a small amount of inexpensive material to build it, is easy to erect, is durable, can be easily moved from place to place without tearing the cross frames to pieces and hay is easily stacked and as easily removed from the stack.

Sun Cured and Shade Cured Cowpea Hay.

As is well known there is great difference in the appearance of cowpea hay cured in the sun and that cured in the shade; stock also prefer that cured in the shade. To learn if there was any loss or difference in the two hays differently cured, two samples of hay, one cured in the sun and the other in the shade, were furnished the Station chemist for analysis. The analysis was made, but it revealed no practical difference in the two samples. When pea hay is cured in the sun the long exposure to sunlight and dews hardens the stems and the palatability of the hay is doubtless impaired.

The Feeding Value of Cowpea Hay.

The feeding value of cowpea hay for fattening steers, feeding milch cows and horses is too well known to require a discussion here, though it may be of interest to state briefly the results of two different feeding trials made this year in which pea hay and cotton seeds were the feeds used. Other trials in which pea hay and seed were used have been previously reported.

Two yearling steers were fed for thirty-seven days from January 23d to March 1st.

Weight at Beginning.	Weight at End.	Total Gain.	Gain per Day.
484	596	112	3
472	570	98	2.6

Two 3-year-old steers were fed for eighty-seven days from January 23d to April 20th.

Weight at Beginning.	Weight at End.	Total Gain.	Gain per Day.
946	1200	254	2.92
876	1150	274	3.14

The steers were fed a ration according to the following proportion, which is about the proper one of seed and pea hay to feed per day: To a fattening steer of 1,000 pounds live weight, 20 pounds hay and 13.6 pounds cotton seed. Pea hay with a good crop of pods on the vines will maintain stock in good condition without other food.

Forage Plants on Sandy Loam Soils.

Several kinds of forage plants were planted at Newport for their yields of forage on the sandy soils of the Station. All were planted in rows three feet apart and without manure of any kind. Each plant was cut just as the heads were appearing, the fodder then was not coarse nor so difficult to

cure. Three cuttings were made except of Teosinte, which was cut only once; the last cutting was done just before frost. The fodders were weighed in January when perfectly dry.

	Yield per Acre.			
White Millow Maize	6,466	pounds	dry	fodder.
Kaffir Corn	5,178	"	"	"
Yellow Millow Maize	6,239	"	"	"
Pearl Millet	4,798	"	"	"
Sorghum, Early Amber	7,426	"	"	"
Jerusalem Corn	3,283	"	"	"
Teosinte	7,098	"	"	"

Jerusalem corn grew very little after the second cutting. It is grown for grain as well as for forage. Sorghum was difficult to cure especially so on account of the frequent rains. The frequent rainfalls, dews and atmospheric moisture in this section make the production of forage from forage plants more or less difficult, and these yields on sandy soil are not entirely satisfactory.

Oats for Hay.

In the spring of 1892 oats were planted on the Newport Station without fertilizers for hay. They were cut just at blooming and were easily cured. A little rust appeared before cutting, but the hay was of good quality and was readily eaten by all stock. The yield per acre was 2,000 pounds of good dry hay. Soil similar in fertility, except that peas were grown on it and the vines turned under the previous year, was sown to oats in October, 1892, and with 85 per cent stand, yielded 3,000 pounds of dry hay per acre. The variety sown was Red Rust Proof. If a more leafy variety be planted for hay a greater yield would be made. Of several varieties tested for hay at the Kansas Station, Blue Grazing Winter and Black Prolific varieties made the largest

yields. Rust was appearing just as the oats were cut, but it need be feared but little on oats for hay as they will be ready to cut before it appears or at least before much damage is done.

When the oat crop is intended for grain it would be advisable to cut for hay if rust appeared and threatened to ruin the crop. In that case it would be better to plant a good grain producing variety. Red Rust Proof and Black Russian are commonly planted with good success.

After the oats were taken from the first plot it was sown in Whipporwill cowpeas for hay. The yield of dry hay per acre was 2,600 pounds, so the total yield of dry hay from that land was 4,600 pounds. No fertilizers were used and the soil is not very fertile, being sandy loam badly in need of vegetable matter. The peas following the oats put the soil in excellent condition for other crops the following year. On the sandy soils of the eastern and southern part of the State oats rust more or less and sometimes to the extent of destroying the crop for grain. On that account many farmers have abandoned oats, but that does not seem entirely necessary because the oats are not ruined for grain by rust every year and when they do rust they could be cut for hay when it appeared that the rust would ruin the crop if allowed to stand to mature grain. Cowpeas could be planted after the oats were cut and a good crop of pea hay made, and the pea roots would help to maintain the soil. The practice of growing oats for hay or grain followed by peas for hay is an excellent one. *From the experiment it appears that oats are profitable to grow for hay on sandy soils, sown either in fall or spring, and that they will be free from much damage by rust.*

Clover and Grass Experiments.

A large number of grasses and clovers are on trial at the Station and at the two Branch Stations. The difference in the character of the soil and climate of the State prevents all grasses and clovers from succeeding alike in each section and it is expected by these trials to determine the best ones for hay and for grazing for all parts of the State. Another object of the trials is to determine the best grasses and clovers for winter and summer pasture.

The results of these trials will be reported as soon as obtained. Some experiments with hay grasses for the northwestern part of the State on clay soils will be reported this fall.

R. L. BENNETT,
G. B. IRBY, *Assistant.*

NOTE. —Letters are frequently received inquiring for places to secure books on various agricultural subjects and addresses of seed houses, and replies have been made to them by letter. But to supply such information to those that may hereafter need it, the following books and seed houses are mentioned:

Books.—Barry's Fruit Garden; Bailey's Nursery Book; Bailey's Horticultural Rule Book; Miles' Stock Breeding; Stewart's Feeding Animals; Allen's American Cattle; Coburn, Swine Husbandry; Flint's Milch Cows and Dairy Farming; Youatt on Sheep; Wright's Practical Poultry Keeper; Weed's Insects and Insecticides; Smith's Diseases of Field and Garden Crops; Johnson's How Crops Grow; Johnson's How Crops Feed; Greiner's Practical Farm Chemistry (manures); Miles' Agriculture, J. E. Bryant Co., Toronto, Ontario; Law's Farmers' Veterinary Adviser; Sanders' Insects Injurious to Fruits, J. B. Lippincott & Co., Philadelphia, Pa.

Any of the above books, except Miles' Agriculture and Sanders' Insects, can be bought of Orange Judd Company, 52 Lafayette Place, New York, and Rural Publishing Company, corner of Chambers and Pearl streets, New York. Those who desire books on special agricultural subjects can secure them by writing to those publishers. They will send descriptive catalogue of books on application.

Seed Houses.—The under mentioned seed houses are extensive dealers and growers of farm and garden seeds and will furnish catalogues upon application:

T. W. Wood & Son, Richmond, Va.

Richard Frotscher, 15 and 17 Du Maine street, New Orleans, La.

Plant Seed Campany, 812 Fourth street, St. Louis, Mo.

W. Atlee Burpee & Co., 475 Fifth street, Philadelphia, Pa.

James M. Thorburn & Co., 15 John street, New York, N. Y.

Vaughns' Seed Store, 146 Washington street, Chicago, Ill.

Bulletins Published by the Station Since July, 1891.

Copies of these bulletins can be had free upon application to R. L. Bennett, Director, Fayetteville.

BULLETIN No. 16.—*Ringworm.*—Nature and Treatment of a Prevalent Skin Disease of Young Cattle.

BULLETIN No. 17.—*Horticulture.*—Grapes: Varieties Best Adapted to Arkansas. Strawberries: Keeping Qualities, Varieties. Raspberries. Plums.

BULLETIN No. 18.—*Agriculture.*—Some Cotton Experiments.

BULLETIN No. 19.—*Manures*— And Some Principles in Farm Manuring.

BULLETIN No. 20.—*Animal Parasitism.*—Some Texas Fever Experiments.

BULLETIN No. 21.—*Horticulture.*—Grapes: Some Insects and Fungous Diseases and their Remedies; Spraying Apparatus; Apples and Grapes in Arkansas.

BULLETIN No. 22.—*Agriculture.*—Sorghum and Sugar Cane Culture. Syrup and Sugar Making on Small Farms. Some Field Experiments with Cantaloupes and Corn.

BULLETIN No. 23.—*Cotton.*—Maintenance of Cotton Soils and their Improvement Without Commercial Fertilizers. Feeding Vegetable Matter to Cattle Before Using as a Fertilizer. Importance of Seed Selection. Injury to Lint by Ginning and Exposure to the Weather. Classification of the Varieties and Culture of Each. Avoidance of the Boll Worm and the Cotton Caterpillar.

BULLETIN No. 24.—*Fodder.*—Explanation of Terms Used in Fodder Analysis. Qualities which Determine the Market Value of Hay. Methods of Securing Fodder from Corn, and the Effect on the Yield of Grain. Composition of the Cowpea at Different Dates from Flowering to Ripen-

ing. Some Further Data upon the Growth of the Cowpea at Different Dates During the Period from Flowering to Ripening. Some Further Data upon the Growth of the Cowpea with Special Reference to the Transfer of Dry Matter and Nitrogen from Roots, etc., to Peas. The Fertilizing Value of the Cowpea.

BULLETIN No. 25. — *Animal Pathology*. — Unsound Corn and Forage as a Cause of Disease in Live Stock. Colics in Horses and Mules. Some Further Experiments with Texas Cattle Fever.

BULLETIN No. 26. — *Horticulture*. — Spraying Apple Trees. Spraying for Apple Scab. Spraying for Bitter Rot. Prevalence in the State of Apple Scab and Bitter Rot. Varieties of Apples in the State Reported as Surest Bearers. Some Apples Adapted to All Sections of the State. Arkansas Seedling Apples.

BULLETIN No. 27. — *Agriculture*. — Experiments at the Northeast Station. Late Crops for Overflow Lands. Corn: Varieties for all Sections of the State, Corn Culture. Rotation of Crops. Cotton Culture. Egyptian Cotton— Two Varieties. Stack-Frame for Curing and Storing Cowpea Hay. Cowpea Hay. Oats for Hay. Forage Plants. List of Some Agricultural Books and Seed Houses.

SUMMARY, WEATHER RECORD AT NEWPORT EXPERIMENT STATION FOR SEASON OF 1893.

APRIL.				MAY.				JUNE.				JULY.				AUGUST.				SEPT.				OCT.			
Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.
1	80	61	.....	1	66	53	1.09	1	76	59	..	1	86	64	.18	1	85	69	.....	1	87	52	.....	1	86	73	
2	83	63	.....	2	67	52	.....	2	76	60	.27	2	86	66	t'ce	2	86	60	.....	2	87	53	.....	2	83	68	
3	84	60	.....	3	74	57	.....	3	80	65	1.14	3	88	67	.....	3	82	66	.....	3	88	53	.....	3	72	56	
4	86	64	.....	4	80	52	.....	4	86	68	.....	4	91	64	t'ce	4	84	70	.....	4	90	54	.....	4	75	46	
5	90	70	.....	5	82	60	.....	5	82	60	.58	5	91	62	.....	5	90	66	.....	5	92	58	.....	5	79	48	
6	90	60	.....	6	80	57	.54	6	77	60	.....	6	92	70	.....	6	91	66	.....	6	82	65	.....	6	72	51	
7	88	68	....	7	78	57	.15	7	78	58	.....	7	94	73	.....	7	93	67	.....	7	86	57	.....	7	77	44	
8	88	69	.....	8	78	55	.25	8	82	58	.....	8	91	74	.....	8	95	68	.....	8	81	58	t'ce	8	81	47	
9	89	67	.....	9	79	60	.....	9	88	62	.....	9	89	71	t'ce	9	95	67	.....	9	67	63	1.44	9	83	53	
10	86	60	.09	10	85	57	.....	10	89	66	.....	10	89	68	.....	10	90	63	....	10	79	66	.24	10	80	48	
11	87	62	...	11	77	62	.07	11	90	68	....	11	91	67	.....	11	85	69	.97	11	79	67	.14	11	82	52	
12	84	64	.18	12	81	58	.75	12	88	66	.....	12	90	68	....	12	85	66	.....	12	85	65	t'ce	12	80	48	
13	79	58	.19	13	85	57	.....	13	86	68	....	13	92	68	.....	13	88	62	.....	13	90	65	....	13	71	44	
14	68	38	3.15	14	77	64	.....	14	87	66	.....	14	92	72	.....	14	90	65	.....	14	96	73	.....	14	66	52	
15	58	34	.26	15	78	64	.17	15	88	62	.....	15	93	74	.....	15	91	66	.....	15	96	71	.....	15	64	38	
16	64	41	.....	16	75	55	.....	16	86	66	....	16	92	72	t'ce	16	91	70	.....	16	85	65	.....	16	64	33	
17	74	54	.....	17	71	50	.....	17	89	67	....	17	87	71	....	17	90	73	t'ce	17	82	47	....	17	70	34	
18	76	46	....	18	78	49	....	18	90	68	.....	18	87	68	.39	18	90	70	.....	18	89	54	..	18	70	37	
19	74	60	.58	19	84	58	.....	19	86	71	t'ce	19	85	68	1.87	19	93	59	.....	19	93	60	....	19	73	38	
20	66	46	...	20	85	65	....	20	80	71	.37	20	85	67	.....	20	89	61	....	20	92	63	.....	20	74	42	
21	65	44	....	21	84	60	....	21	86	71	.....	21	87	67	.....	21	87	59	.....	21	91	65	....	21	73	38	
22	70	38	....	22	83	65	.....	22	83	66	.13	22	89	65	.....	22	89	55	.....	22	88	67	....	22	72	36	
23	69	39	.....	23	79	54	.23	23	83	57	.....	23	90	65	.....	23	87	55	....	23	77	68	.45	23	75	37	
24	80	47	.....	24	79	49	.....	24	88	67	.....	24	91	66	.....	24	92	61	.....	24	76	65	1.95	24	71	42	
25	76	58	1.55	25	87	56	....	25	94	72	.....	25	94	68	.....	25	85	68	.83	25	74	54	.41	25	70	39	
26	77	59	.85	26	88	69	.34	26	89	71	...	26	94	70	.....	26	87	65	....	26	69	42	.....	26	69	57	
27	76	50	....	27	74	63	1.33	27	88	62	.....	27	92	73	....	27	90	64	....	27	71	51	....	27	63	36	
28	83	55	....	28	70	57	1.08	28	87	64	....	28	95	65	....	28	83	65	....	28	75	45	....	28	60	38	
29	84	65	.....	29	77	50	....	29	90	62	.....	29	95	74	....	29	79	56	.....	29	80	54	.....	29	54	32	
30	83	60	2.47	30	72	57	....	30	81	68	t'ce	30	95	71	.56	30	81	57	.....	30	86	65	2.04	30	59	29	
31	...	...	.	31	82	62	1.90	31	...	...	.....	31	90	70	.84	31	84	54	.....	31	..	...	.....	31	67	34	

Weather table prepared by G. B. Irby, Observer and Assistant Agriculturist at Newport Station.

Southern Branch

Arkansas Agricultural Experiment Station.

At a meeting of the Board of Control of the Arkansas Agricultural Experiment Station held in the fall of 1892, a Branch Station was established at Camden, centrally located in the southern third of the State. The soil and climate of Arkansas divides the State into three distinct agricultural divisions, hence the necessity for branch stations. The main Station at Fayetteville represents the division with high altitude and clay soil, which embraces the northwestern portion of the State; the Newport Branch Station represents the eastern division and alluvial soil; the Southern Branch Station represents the southern and southwestern portion of the State which has a sandy soil, and pine predominating in the original forest growth. The spring seasons at the Southern Branch are from *four* to *five weeks* in advance of the spring seasons at Fayetteville, while Newport is intermediate—the difference being due to latitude, altitude and other causes.

The Southern Branch Station is just within the western corporate limits of the city of Camden, Ouachita County, the Iron Mountain Railroad crossing one corner of the property which consists of about twenty acres of land drained by a small stream. The selection of this particular piece of property was judicious, it being well suited to the purposes for which it is being used and conveniently located. It consists of comparatively level sandy upland, hillsides and wet lowland, the three characters of soil so prevalent in the southern third of the State.

When work was begun in the latter part of January, 1893, the Station consisted of twenty acres of land inclosed by an inferior fence. Its most conspicuous feature was the

total absence of improvement. The upland portion was well sodded in Bermuda grass, the hillsides cut to pieces by gullies, and the lowland partially covered with stagnant water and overgrown with willow, alder, sweet gum, black gum and buttonbush. The upland and particularly the hillsides were poor, while the lowland required both clearing and ditching to render it capable of being cultivated. There is present on a minimum of area a maximum of conditions prevalent in South Arkansas—conditions necessary to the proper carrying on of the work intended to be done by this Branch Station. The character of the Station soil, the level hill portion where experiments will be mainly conducted, a light sandy loam without good clay subsoil.

The work of 1893 other than actual experimentation was:

a. Building the necessary fences and clearing bottom land.

b. Terracing, ditching and underdraining.

c. Building a barn with wagon, tool, feed and cotton rooms, mule stalls and hayloft.

d. Planting orchard embracing many varieties of peaches, apples, pears, plums, quinces, apricots, figs, etc.

e. Planting vineyard embracing thirty varieties.

f. About one-third of the place was planted in corn, cotton, oats, potatoes, tobacco, peas, rye, barley and vegetables.

g. A neat and substantial cottage was erected during the latter part of the year.

h. Building potato house of logs and chinked with mud.

The condition of the soil and the work required to put it in shape for experimentation limited the experiments done during the year.

At the present time the Station is in good shape and systematically planned experiments are under way. The lines of experiments being pursued at this Branch Station are agricultural and horticultural, with reference to the soil and climate prevailing in this third of the State. *Special attention* will be given to experiments in *truck farming* for northern markets, as the soil and climate are very favorable for profitable farming in that line. These experiments will be mainly applicable to the entire State. Those engaged in truck farming find it to be one of the most profitable lines of farming and the number engaged in it is increasing annually. For those reasons it is expected that the experiments will be very useful.

R. L. BENNETT, *Director.*

Rye for Green Winter Feeding.

The value of rye as a green winter feed for all live stock, including hogs and even poultry, is appreciated by but few. The general custom is to sow broadcast for grazing, but planted in drills and cut and fed green it affords a very much greater quantity of food in a better condition, and injury from cattle trampling the soil in wet weather is avoided.

About the first of November, 1893, soil that had been previously fertilized with stable manure and cotton seed meal was thoroughly prepared and marked off in eighteen inch rows and an additional application of 300 pounds cotton seed meal and 100 pounds kainite per acre made in the drills. The rye was put down very thick in drills one and a half inches deep and as narrow as could be made for that depth. It is of considerable importance to have the seed in a narrow drill for two reasons—first, rye is inclined to spread flat upon the surface of the soil in its early stages of growth, and second, when planted in a narrow drill it is much more easily cut by hand, not only on account of its more upright growth, but because it can readily be grasped with one hand and cut with the other, thus keeping it free of trash, sand, etc.

The first cutting was made about the middle of January, the second on March 9th, the third on April 11th and the fourth on April 28th. A quantity sufficient to feed two mules, both night and morning, was cut each afternoon, except when the rye was frozen. If disturbed while frozen the plants will be injured, if not killed. By the time the plot was cut over, that portion upon which the first was cut was ready for the second cutting. There was, however, about fifteen days between the beginning of the first and second cutting upon which there was none cut. By April 11th the plot had all been cut twice. The third cutting was begun on April 11th when the rye was coming well into boot. The cutting of the 28th was in reality a continuation of the

third cutting, but for the sake of convenience I will designate it as the fourth, as it was made when the rye was in full blossom, but, from that portion of the plot that had been cut but twice previously. The yield per acre of each cutting is given in the following table:

Date of Cutting.	Green Weights Per Acre.	
Middle of January	6,608 lbs.	6,608 lbs.
March 9th	9,448 "	9,448 "
April 11th (In boot)	13,230 "	
April 28th (In blossom)		26,460 "
Total yields per acre	29,286 lbs.	42,516 lbs.

One hundred pounds each of that in blossom and in boot were weighed green and cured for hay to determine the loss in the process of curing. That cut April 11th, while in the boot, lost 75 per cent and the cutting of April 28th made while the rye was in blossom lost 65 per cent. Each lot was weighed at intervals until there was no further loss, but a slight increase when the atmosphere was moist. The cutting of April 11th made an increase in weight slightly greater during moist weather than the cutting of April 28th. The 13,230 pounds of green rye cut while in boot cured 3,307 pounds of hay, while the 26,460 pounds of green rye cut while in blossom cured 9,261 pounds of hay.

A sample of each lot was sent to the Station chemist who kindly furnished the following analysis:

	Cut in Boot.	Cut in Blossom.
Water	9.91	9.00
Ash	6.22	5.26
Crude Protein	13.25	8.31
Crude Fiber	28.89	36.40
Ether Extract	2.95	2.45
Carbohydrates	38.78	38.58
	100.00	100.00

The nutritive ratios of the cutting made while in the boot was 1:5.2, that of the cutting made while in blossom was 1:10.0.

The *hay* cured from the cutting made while the rye was in the boot contained 1,282.9 pounds of carbohydrates and the late cutting 3,572.9, practically treble the other. The crude protein of the blossom hay was 769.6 pounds against 438.1 of the rye cut while in the boot.

The two lots were fed to mules and were eaten with great relish. I thought some preference was given to the hay from the cutting made when the rye was in blossom.

Fertilizer Experiments with Rye.

Plots of rye were planted in November, 1893, for the double purpose of determining the effect upon the yield from plowing in a crop of pea vines and the effect of top dressing with nitrate of soda, muriate of potash, acid phosphate separately and all three combined. Ten plots were planted, five of which were on soil from which a crop of oats had been harvested the previous spring. After the oats were removed whippoorwill peas were planted in two and a half foot rows. The vines, from which the peas had not been gathered, were turned under a few days before the rye was planted. The remaining five plots were planted after corn, in which no peas were planted.

On April 11th, when the rye was in the boot the top dressing was applied by hand to both series of plots. All the plots were harvested April 28th for hay, yielding the following green weights.

(*a*) PEAS TURNED UNDER AFTER OATS.

No. of Plot.	*Fertilizer Per Acre.*	*Yield Green Rye Per Acre.*
1.	100 pounds nitrate soda	9,665 pounds.
2.	75 " muriate potash	4,149 "
3.	125 " acid phosphate	4,704 "
4.	100 " nitrate soda 75 " muriate potash 125 " acid phosphate	10,102 "
5.	No topdressing (average two plots	3,867 "
	Average five plots	6,497 "

(*b*) AFTER CORN. NO PEAS TURNED UNDER.

No. of Plot.	*Fertilizer Per Acre.*	*Yield Green Rye Per Acre.*
1.	100 pounds nitrate soda	4,245 pounds.
2.	75 " muriate potash	2,922 "
3.	125 " acid phosphate	3,142 "
4.	100 " nitrate soda 75 " muriate potash 125 " acid phosphate	5,926 "
5.	No top dressing (average two plots)	2,343 "
	Average five plots	3,715 "

The soil upon which the experiments were conducted is light sand, very deficient in vegetable matter and other fertilizing ingredients and inclined to bake, particularly after heavy rains. The peavines left plots *a* in an excellent mechanical condition when the rye was harvested, but plots *b*, upon which no peas were grown were in a poor condition, breaking into large clods when plowed.

The top dressing was applied April 11th. On the morning of the 14th from 6 to 11 o'clock, a gentle rain fell (.16 of an inch). In the afternoon of the same day the nitrate of soda plots and the plots where all three fertilizers had been applied could readily be distinguished some distance from the others by their richer green color. Three weeks later the muriate of potash plots were of a richer green than the nitrate of soda. Acid phosphate had a tendency to induce a taller growth of stalks and the development of more perfect heads and grains of rye, but the leaves were less green and shorter.

The same tests were being conducted with barley, but it was all killed by the unusually cold weather of January, while the rye was but slightly injured. This cold weather also killed cabbage, celery, turnips, lettuce, beets and onions.

Onions From Seed.

On March 13th nine varieties of onions were planted in drills fertilized with cotton seed meal and kainite. The seed should have been planted in January or early in February, for planted then in the open ground, the plants have suffi-

cient time to make a good growth before the grass and weeds appear; as it was, the grass and weeds began to grow as the onions did and were difficult to control. The soil was poor and would barely have produced fifteen bushels of corn unaided by fertilizer.

Very frequent cultivation was necessary to prevent crowding out by weeds and grass. The rows were two and one-half feet apart—one or one and one-half feet would have been sufficient—but they were planted two and one-half that the plow might be used in their cultivation. When the young plants had attained a diameter of about one-eighth inch they were thinned to four inches in the drill, and the removed plants transplanted to other rows prepared as the seed bed, and set four inches apart. The tops of the transplanted seedlings were cut back about one-half, and the roots one-fourth their length. Each variety was gathered as ripeness was indicated by the falling of their tops.

The following table gives the yield per acre of each variety:

NAME OF VARIETY.	YIELD PER ACRE.	
	Transplanted.	Not Transplanted.
Bermuda	131 bu.	129 bu.
Early Red	134 "	140 "
Early Red Globe	172 "	157 "
Giant White Tripoli	104 "	90 "
Large Red Globe	89 "	93 "
Giant Red Rocco	126 "	118 "
Mammoth Silver King	81 "	86 "
White Globe	96 "	94 "
Yellow Giant Globe	132 "	113 "
Average	118⅓ "	113⅓ "

The transplanted plots yielded about 15 per cent more marketable onions than those not transplanted.

The plots upon which the onions were grown without transplantation, required more than enough additional labor (in keeping free from weeds and grass) to balance the labor

of transplanting. All were fertilized alike, 400 pounds cotton seed meal and 100 pounds kainite per acre being used in the drill and top dressed with 200 pounds cotton seed meal and 100 pounds kainite when the onions were from one-fourth to one-half inches in diameter. There was no apparent difference in the keeping qualities of the two lots, both being readily kept until February.

Transplanted Salsify, or Oyster Plant.

Salsify is a vegetable found in few gardens, but should be in all. Most persons who have eaten it when properly prepared are fond of it, and it being ready for use during the fall, winter or early spring, when there is a scarcity of fresh vegetables, is greatly in its favor for more general cultivation. It is grown readily, and a small fraction of an acre will yield an abundance for a large family. Its cultivation is similar to that of carrots, parsnips or beets, and the seed may be planted in this latitude any time between September and April, but preferably in the fall or winter. The soil should be a loose loam broken thoroughly and deep. In the spring of '93 a plot was planted, the soil being prepared by first thoroughly breaking deep with turning plow and rows opened ten or twelve inches deep and manured with well rotted stable manure, cotton seed meal and kainite. The rows were bedded, raked to nearly a level and the seed planted half an inch deep. It is preferable to plant on soil well fertilized the year before. When the plants had attained a sufficient size they were thinned to four inches in the drill and the removed plants transplanted to rows prepared as the first and set the same distance in the drill. That cultivation might be done with plow the rows were made two-and-a-half feet apart, but one foot between rows is sufficient. The stand was perfect in both cases. Cultivation was frequent with both plow and

hoe, but shallow. In January the plots were dug and the roots weighed with the following result:

Not transplanted	3,978 pounds per acre.
Transplanted	4,410 pounds per acre.

The plot not transplanted was much more difficult to keep free from grass and weeds than was the transplanted plot.

The transplanting was done with dibble, care being taken to have roots straight and vertical. The roots of the transplanted plot were found when dug to be more branched than those not transplanted and had a profusion of fibrous roots. They were also more tender when cooked.

The roots may be taken up in winter and hilled with potatoes or turnips, set in trenches or remain undisturbed, only the severest cold affecting them. Last winter the roots were but slightly injured by cold as low as eight degrees above zero.

Cooking Salsify.—Scrape, boil, slice or mash, and prepare as oysters for soup or stew; or, slice, or mash and fry in batter or make pie as with oysters. The name *oyster plant*, or *vegetable oyster* is appropriate—the salsify stew soup and pie having flavor very suggestive of the luscious bivalves.

Late, or Fall Raised Irish Potatoes.

The report of the U. S. statistician for 1890 gives the average cash value of all crops raised in Arkansas for the last ten years at $16.09 per acre. The value per acre for ten years of the different leading crops according to the same report was:

Corn	$10.07
Wheat	7.23
Oats	7.68
Rye	0.54
Potatoes	**47.14**
Cotton	20.08
Hay	13.90

The average value of potatoes from *one acre* is equal to the average value of cotton from *two and a third acres*. Why are not potatoes more generally cultivated? Nearly any one who has attempted to raise potatoes for winter market in the South can answer this question. They are difficult to keep—they rot; hence little effort has been made except in a few localities to grow potatoes except for immediate use. However, some attention has recently been given to what is known generally as a "Fall Crop" or "Second Crop" of Irish potatoes—a crop planted after or about the time the spring crop is harvested. This second crop can readily be kept through the winter and is comparatively free from the rot that is so destructive to the spring crop. This rot is believed generally to be the result of a parasitic fungus *(Phytophthora infestens)*. The spring crop, gathered in June, July or August, is surrounded by conditions favorable to the germination of not only the spores of Phytophthora but other fungi and become inoculated. On the other hand the better keeping qualities of the second crop may be due to the absence of conditions favorable to the growth of the fungus disease or diseases, attacking the potato. The spores may be in an inactive state when the second crop is harvested, or potatoes may be grown and harvested under climatic or other conditions unfavorable to the germination of the spores.

Last year experiments were begun, the object of which were to determine:

a. How can the spring grown potatoes be kept?

b. How can a second crop be grown?

The work of last year was *preliminary*, but the results obtained from planting a second crop are deemed worthy of publication notwithstanding unfavorable circumstances and conditions attendant upon the undertaking. The soil selected was sandy, poor, and cultivated the year previous in corn which became foul with Bermuda after it was laid by. For

three months prior to the planting of the potatoes, the plots were either plowed or harrowed at intervals of from ten to twenty days and kept free from all vegetation. The object of this was to kill the Bermuda.

Two bushels of the spring crop of potatoes were selected on the 15th of July. One bushel was spread upon the floor of the second story of the barn. By the first of September 50 per cent of these had rotted, and practically all by October 1st. They had thorough ventilation and were placed in the northeast corner to avoid extremes of temperature.

One-half of the other bushel was planted the last week in July. The rows were opened with turning plow, and 200 pounds cotton seed meal and 50 pounds kainite per acre applied. Scooter was twice run in each row to thoroughly spread the fertilizers. Whole potatoes were dropped and covered with one furrow made by turning plow, leaving the rows nearly level. The remaining half bushel was bedded in the following manner:

Nine square feet of earth was removed to the depth of 5 or 6 inches. The potatoes were spread on the bottom of this excavation so that they did not touch each other. They were covered with the soil that had been removed, and watered thoroughly. Whenever the bed appeared to need it, the watering was repeated, the water being put on late in the afternoon and the surface of the bed loosened with rake on the following morning. The plants begun to show above ground in about ten days and the bed was well covered in three weeks, at which time those planted in rows were beginning to come, but very slowly and irregularly. As the plants in bed attained sufficient size they were transplanted to rows prepared as described above and at the same time. They were watered when transplanted and but few of the plants wilted. They grew slow as the weather was hot and the soil dry. A very small per cent died. An additional application of

100 pounds cotton seed meal and 25 pounds kainite was made when the potatoes were plowed the last time. During the month of October only .65 inches of rain fell, this curtailed the yield considerably as during this month the crop was made. Rains early in November induced a new growth of both vines and potatoes, and a new crop of the latter were just forming when the crop was harvested. The first killing frost occurred November 13th and the potatoes dug immediately afterwards, yielding as follows:

Whole potatoes dropped every 18 inches ..... 64 bushels per acre.
Plants set every 18 inches ..... 86½ bushels per acre.

The increase in yield of the transplanted plants over the others was augmented by the difference in the stand on the two plots. The stand of the *transplanted plot* was about 95 per cent, while that of the planted plot was about 60 per cent. That a comparison on the basis of a perfect stand might be made, 100 hills each of the two plots were dug and the yield per acre calculated with the following result:

Whole potatoes dropped every 18 inches ..... 99½ bushels.
Plants set every 18 inches ..... 88 bushels.

While it appears that the potatoes planted in the ordinary manner will give a greater yield than those transplanted, the stand and other things being equal, the latter have a decided advantage in the greater certainty of securing a good stand, and securing a stand is the greatest obstacle in the way of the production of a fall crop.

Equal quantities of potatoes from both plots were stored during the winter and on examination on the 1st of March showed them in perfect condition. Only one potato was found that had rotted and that one had been badly bruised. Both plots were planted on very nearly a level. During cultivation the rows became gradually ridged and when last plowed were about four inches higher than the middles. Level culture promotes the conservation of moisture—an im-

portant item with the fall crop. For the same purpose the surface of the soil should be kept constantly in a thoroughly pulverized condition, in which condition it performs some of the important offices of a mulch—retains the moisture in the soil, prevents the soil from baking, and admits air and heat.

Preparation of Soil for Cotton.

It is often the custom, when cotton follows cotton, to bed on the middles of the rows of the previous year without breaking the old middles. The same is the case when cotton follows some other crops, but less frequently. The crops that cotton follows, other than cotton, are generally corn and oats, and the growth of grass and weeds that spring up after the corn is laid by and the oats harvested necessitates, in the majority of cases, the broadcast breaking of the soil. We have heard it argued by cotton planters that, inasmuch as the cotton plant is tap-rooted, it requires a firm bed to insure its making a good root growth and that the beds should be made on unbroken soil. On the other hand others claim that better results are obtained by either breaking broadcast or bedding in the fall and rebedding in the spring, or both breaking and bedding in the spring without the previous fall breaking. As to whether the soil should be broken in fall or spring, would largely be determined by the character of the soil and its condition. Should there be a rank growth of vegetation on the surface in the fall it would be better to turn it under that it might, by decomposition, be converted into plant food, unless the soil was particularly subject to washing. If such should be the case its remaining on the surface would largely prevent washing. It is doubtful whether very light soils receive most injury or benefit from fall breaking. Stiff or harsh soils are materially improved by thorough fall breaking that the freezes of winter may

better act upon them and improve their mechanical condition by disintegration.

As work was not begun on the Station until about February 1, 1893, the fall breaking was not tried, but in February four plots of cornstalk land with good growth of Bermuda grass were selected, two were broken with double turning plow and two were left unbroken. One plot each of the broken and unbroken were bedded in February and the others not disturbed until May 3d, when they were bedded just as were the others in February. May 3d an iron tooth harrow was drawn over all the beds and the cotton planted. The plants appeared above ground on the same day and no difference was noticed until August, when the plots bedded on unbroken soil were not growing so well and seemed to suffer more from dry weather and the hot sun, and begun to shed more than the plots bedded on broken soil. These plots seemed to be more vigorous in growth and the leaves had a decidedly better color than plots bedded on unbroken soil and were affected about half so much by the rust or leaf spots.

The following table gives the weight per acre of seed cotton gathered from the four plats:

UNBROKEN SOIL.

Bedded in February	724 pounds.
Bedded 3d of May	754 "

BROKEN SOIL.

Bedded in February	869 pounds.
Bedded 3d of May	901 "

NOTES.—The increase of beds made in May over beds made in February was 62 pounds seed cotton per acre.

Beds made in May on unbroken soil gave an increase of thirty pounds over beds made in February on unbroken soil, and beds made in May on broken soil gave an increase of

thirty-two pounds over beds made in February on unbroken soil. But these differences are too small to be of practical value in the experiment, especially as the experiment is only one year's trial.

The increase in yield of beds made on broken soil over that of beds made on unbroken was 292 pounds of seed cotton per acre.

All four plots were covered with about half a sod of Bermuda grass, which was vastly more difficult to suppress on the unbroken beds than on those broken. This fact, perhaps, accounts for some of the difference in the yields from the broken and unbroken plots.

The unbroken plots were more difficult to cultivate both with plow and hoe than the broken plots.

The unbroken plots suffered more from shedding than the broken, but the unbroken beds made in May shedded little if any less than the unbroken beds made in February. The cotton opened on the unbroken beds before it opened on the broken, and 10 per cent of the cotton on the broken beds was picked after all had been gathered from the unbroken beds.

One hundred plants growing on the unbroken plots had 132 imperfect bolls, while the same number of plants growing on the broken plots had only forty-three imperfect bolls. By imperfect bolls is meant bolls with one or more locks not fully developed, or with abortive lint or seed.

The four plots were fertilized each with—

140 pounds acid phosphate per acre.
140 pounds cotton seed meal per acre.
70 pounds kainite per acre.

The experiment indicates a profitable difference in favor of thorough breaking, but one or two more trials are necessary for reliable conclusions, though thorough breaking

would doubtless be beneficial on all clayey soils and soils that pack and run together after rains as the Station soil does.

Bermuda Grass (Cynodon Dactylon).

When the Branch Station was established here a considerable portion of the grounds was well set in Bermuda grass. It had been allowed to spread irregularly by injudicious cultivation, rendering some of the otherwise best portion of the grounds unfit for experiment purposes. On the other hand there were portions of the grounds free from it, upon which it was considered desirable to have it growing. These places were the space around the barn, the roads, portions of the pastures, hillsides especially subject to washing, terraces, hillside ditches, etc. While Bermuda blossoms profusely, it rarely produces seed in the United States, but propagates by its short jointed procumbent branches, each joint of which is capable of producing a new plant. These branches very frequently become covered with earth and partake of the nature of underground stems and are popularly called roots. (The roots proper are fibrous and free from joints.) As each of these joints (or *nodes*) are capable of making a new plant, it follows that each joint must be killed to destroy the grass. It is obvious then that the vital or propagating portion of the plant lies *on* or *just under* the surface of the soil—a fact to be remembered when fighting the grass.

PLANTING BERMUDA GRASS.

Planting Bermuda is a very simple operation. The method I most generally practice and consider the easiest, and the most rapid, is to secure the quantity desired by first plowing a sod and then harrowing or raking the grass into piles or windrows, and, without allowing to become dry, chop the stems into one or two inch lengths. This is easily done either in a feed cutter or by placing on a block of wood and cutting into the desired lengths either with axe or hatchet.

These sections may then be dropped one, two or three feet, or continuously, in furrows and covered with plow; or they may be sown over surface and plowed in; or the soil broken with scooter or turning plow and the grass dropped in the furrows to be covered by the next round of the plow. It may in this way be put in every furrow, in every other furrow, or whatever distance desired in rows or between rows.

Late in the spring of 1893 a small area was planted by dropping the grass eighteen inches apart in every other furrow made by a four-inch scooter in breaking. By fall it was sufficiently established to prevent washing by six inches of rain which fell this spring in twenty-four hours.

Another area was planted by dropping the stems on freshly plowed soil and pressing in with the foot, with good results. Sod was also taken with soil adhering and planted with hoe and spade, but this was slow and laborious, giving no better results than the other methods of planting. Bermuda spreads very rapidly and appears to spread over a greater area of poor, firm soil than of soil in a better condition. Last fall I measured a stem of one season's growth which had attained a length of sixty-nine inches and had a number of lateral branches exceeding two feet in length. It had taken a firm hold and spread over mixed clay and sand (which had been removed from a ditch) as if intentionally to hold the soil in its place.

Aside from being the most valuable of grasses for preventing roads, yards, hillsides, pastures, terraces, ditch banks or bottoms from washing, Bermuda is the most profitable pasture grass for the South, on light or sandy soils, furnishing grazing continuously from April to November, and not infrequently throughout the year. No other grass better survives the hot and dry summer months, so destructive to pastures and hay fields in the South. Its feeding value is superior, and live stock of all kinds prefer it to other grasses.

When the Southern farmer fully appreciates the value of Bermuda for pastures and peavines for hay and manuring, he will be more prosperous.

METHODS OF DESTROYING BERMUDA GRASS.

When Bermuda takes possession of a piece of ground, it forms a most compact sod and is eradicated with considerable difficulty, but less than is generally supposed when treated in the proper manner.

As remarked, portions of the Station property which were wanted for other purposes was well sodded in this grass. Different methods were resorted to for the purpose of destroying it. An area was divided into five plots and treated as follows:

Plot 1.—Plowed and cross-plowed with scooter at intervals of from one to three weeks, each plowing followed by harrow.

Plot 2.—Plowed and cross-plowed with fourteen-inch heel-sweep at intervals of from one to three weeks, each plowing followed by harrow.

Plot 3.—Planted in oats in February. Oats harvested in June and plot immediately treated as plot 1.

Plot 4.—Planted in oats in February, oats harvested in June and plot immediately treated as plot 2.

Plot 5.—Planted in oats in February, oats harvested in June and plot immediately plowed and cross-plowed with scooter and harrowed. One week later planted in cowpeas sown thick in two-and-a-half foot drills. Peas cultivated twice with heel-sweep and harvested for hay in September when plot was again broken with scooter and harrowed.

The results were very satisfactory on all five plots, the grass being practically destroyed, particularly on plots 2 to 5 inclusive. On plot 1, the destruction was not so complete. The first two plots were given the same treatment and at the

same time, except that the plowing was done with scooter on plot 1 and with heel-sweep on plot 2. Throughout the experiment there was more grass on plot 1 than on plot 2, indicating that the heel-sweep did more effectual work than the scooter. The heel-sweep passing under the propagating parts of the plant and cutting the feeding roots left it in a better condition to be harrowed to the surface and killed by the heat of the sun. The scooter cut the sod into a greater number of pieces, but did not sever the fibrous roots which held the plant and made the work of the harrow less effective. As soon after each rain as the soil was sufficiently dry for work, plots 1 and 2 were subjected to a repetition of the above treatment, and again in dry weather, at intervals of from one to three weeks, or as soon as any growth appeared, whether Bermuda or other grasses or weeds. Such a quantity of the dead Bermuda remained on the surface after the first harrowing that it was raked into piles, some of which was put in gullies and the other burned.

The oats on plots 3, 4 and 5 had begun to cover the ground before the Bermuda had made much growth, and when it appeared it was upright, as much so as the oats, and did not spread upon the surface of the soil as it did on plots 1 and 2. The oats served the purpose of not only preventing the Bermuda already there from spreading, but made it more succulent and tender by shading and vastly more susceptible to the effects of plowing, harrowing, and the heat of the sun (when the oats were removed), the combined effects of which left very little after the first treatment. A week later the peas were planted on plot 5 for the purpose of giving the grass, should there be any left, a second shading followed by exposure to the hot sun. The rows were thirty inches apart and the peas planted continuously in the drill. The peas were cultivated twice with 18-inch heel-sweep, two furrows being run the first and one the second plowing. A

warm, dry day in September was selected for the harvesting of the peas for hay. The vines were removed as soon as cut and the plot plowed with heel-sweep and harrowed. There was no grass on the plot when the peas were removed. The alternate shading and exposure to the hot sun in dry weather proves most effectual in killing Bermuda, particularly when the exposure to sun is accompanied by a thorough scarification of the surface of the soil.

The turning plow is not infrequently used for fighting Bermuda and generally with poor results, unless the plow is run shallow. This plow is used in the fall of the year and it is expected to bring the grass to the surface to be killed by freezes. If the plowing is done deep this object is defeated, for the grass (a portion of it at least) is turned under and not up, and really planted again; but if the plowing is shallow the propagating parts of the plants are left near the surface. and if dragged out by the harrow, may be killed. If this is done in dry, hot weather, the results are satisfactory, particularly so if the grass has previously been well shaded by some growing crop, such as oats, rye, barley, peas or millet, but for the complete destruction of Bermuda sod however thick, I recommend the following treatment:

Break close with scooter (bull-tongue), cross-plow with fourteen-inch heel-sweep and harrow thoroughly. A few days later harrow in rye or barley in the fall or oats in the spring. Cut grain for hay and remove from ground. Break again with scooter and heel-sweep as before and harrow in dry weather. If grass is not all killed, plant peas (whippor-will or unknown cowpeas) thick in two and a half or three foot rows and cultivate frequently with heel-sweep until peas lap across rows. If grass still remains, which is very improbable, cut peavines and plow and harrow again. The plowing in all cases should be thorough, no unbroken places being left. By this treatment the Bermuda will be destroyed

and the labor employed for its destruction will have produced two crops in one year on the same soil, either of which will pay for the labor expended for the production of both and the Bermuda killed incidentally and without cost.

The Pocket Gopher (Geomys Breviceps).

In portions of South Arkansas the above little animal is quite common and very destructive to growing crops. In this locality they are generally called "salamanders." In fact but few persons know them by any other name. Another species, common in portions of Georgia, Florida and Alabama, *G. Pinetis* (?), are also called salamanders, but more generally gophers. The salamander proper belongs to a genus of batrachian reptiles having some affinities with lizards, but more with frogs; while the pocket gopher belongs to the order *mammalia*. The salamander proper resembles a lizard, while the gopher resembles a ground squirrel. They are called *pocket* gophers from the fact of their having external cheek pouches. The gopher lives in underground tunnels or burrows and at intervals throws up mounds or "hills" of earth removed from the burrow, and securely closes the opening through which the earth is removed. These tunnels are generally from four to eight inches below the surface, but may be only two or as deep as fifteen inches. In changing their place of abode, which is frequently done, particularly in the spring, they sometimes travel underground similar to the mole (?). One was caught this spring that had in this manner traveled more than 100 yards in one day. The raised earth indicating the line of his travel was at first supposed to have been made by a mole, but on the following day six hills were thrown up near the terminus of the tunnel. He was caught on the third day, after which there was neither evidence of mole nor gopher within 200 yards of the burrow, nor has there been since. Another

came from an adjoining piece of property, crossed under the barn and established himself in the vegetable garden, after having moved eighty yards and traveling a third of the distance mole fashion. No evidence of a mole was noticed before or since his capture. Two other instances of gophers having traveled as moles have been noticed. In all cases this manner of travel was confined to freshly plowed soil. When firm soil was reached no surface evidence of their tunnel was seen except occasional hills.

Before coming to Camden I had but slight acquaintance with the gopher and was inclined to believe the reports of damage done by them exaggerated. In the spring of 1893, while breaking land with a two-horse turning plow, a number of their storehouses were unearthed, some of which contained more than a gallon of peas, corn and other seeds. Weed and grass seeds, stems of Bermuda grass, tubers of coco or nut grass were found in an excellent state of preservation.

While gophers injured to a more or less extent nearly everything planted on the Station last year, the greatest damage done was due to washing of the soil caused by their burrows. During heavy rain, water collected in them and a gully was the result. This was particularly the case on sloping ground, or where their burrow crossed a terrace or hillside ditch. During the heavy rains in March of the present, year when 6.39 inches fell in twenty-four hours, the greatest damage by washing was due directly to these burrows. In one instance a burrow crossing under a hillside ditch caused the ditch to break and a gully averaging one foot deep and three feet wide was made across three terraces which would have otherwise prevented washing as they did everywhere else. Another burrow running under the barn (which is on slightly inclined ground) concentrated the flow of water into two mule stalls. When this was discovered the mules were standing in mud and water up to their knees.

The water entered the burrow in the garden of a neighbor some yards distant. The gopher that made this burrow was caught afterwards and sent to the chief of division of ornithology and mammalogy, Department of Agriculture, Washington, D. C., for identification.

Killing Gophers.

Last spring different methods were resorted to in endeavoring to rid the Station of these pests. By March 1st of the present year I thought them exterminated, but four more appeared, having crossed from adjoining property, but were caught shortly after they were known to be on the place. The campaign against gophers has been conducted on about fifteen acres, the result of which is summarized as follows:

Number Operated Against.		Number Killed.
6	Poisoning with strychnine	1
15	Suffocated with bisulphide of carbon	5
33	Caught in steel trap	33
	Total killed	39

When the strychnine or bisulphide failed the steel trap was used, and occasionally the trap had to be reset once or twice before the gopher was caught. But this was due to the improper setting of the trap in the majority of cases, for after a little practice it rarely failed. Corn, rye and peas soaked in a solution of strychnine were put in the burrows, but I was sure of having killed but one with this poison. Six burrows were treated, but the gopher continued to work in four of them, notwithstanding the disappearance of some of the poisoned seeds. As to whether they were removed by the gophers or not could not be determined. In the fifth burrow the gopher did not appear again. In the sixth he disappeared for several days and returned, but I was not sure of its being the same one—one may have been killed and

another moved into the burrow. The bisulphide of carbon proved effectual only on comparatively level ground. Although care was exercised to introduce it into the burrow at its highest point it frequently failed. Of the fifteen treated I was sure of having killed but five. Bisulphide of carbon should be used with some care, as it is inflammable, explosive and poisonous when taken internally. It is very volatile, its vapor being heavier than air, to which fact is due its efficacy. When placed in the burrow the liquid evaporates and the vapor flows as water would and effects the gopher in a manner similar to the effects of chloroform. The liquid was introduced into the burrow by saturating a ball of cotton or rag with from one to two tablespoons full. These are placed well in the burrow and the opening closed with earth. When the shape of the mouth or opening of the burrow is such as to admit it, the cotton or rag may be first placed in and the liquid poured upon them. If the bisulphide is applied soon after a rain when the pores of the soil are filled with water the effects will be more marked as the gas will be better confined to the burrow.

The bisulphide method of destroying gophers, spermophiles and prairie dogs is favorably reported from Dakota, California and Washington. Here the steel trap was far more effective and required no more time nor labor than the bisulphide. Where the animals exist in large numbers in a small area and more than one in a burrow the bisulphide can be used with greater advantage, but with the species of gopher common here, where only one is found in a burrow, I prefer the steel trap. It is cheaper, more effective and as easily manipulated.

The setting of the trap is a simple operation and when properly done rarely fails to secure the gopher. The opening through which the earth that forms the hill is removed is a short branch of the main burrow. The soil should be re-

moved with hoe or spade, following the branch until the main burrow is reached. Cut into the main burrow *just enough to admit the trap*, and set it so as to have the trigger just below the level of the bottom of the burrow. Sprinkle loose earth around trigger so as to partially conceal trap and cover all with boards and earth to exclude light. By so setting the trap the gopher will pass over it, no matter in which end of the burrow he may be. With a little practice one can become quite expert at catching them, and in a short while after discovering new signs succeed in trapping them with the loss of but little time from other work.

Moles.

While moles are properly insectivorous animals they by no means confine their diet to insects, but subsist largely upon vegetation. The damage done by their tunnels may be greater than the loss from what they actually eat, but either is sufficient to justify killing them.

Many traps and devices have been in use for catching moles, few of them however are successful.

Wishing to ascertain for my own satisfaction some facts regarding the food eaten by moles, I determined to secure some alive. This proved to be such an easy (and interesting) matter that I continued to catch them until not one was left on the Station grounds. The number taken was eleven, five of which were captured in two days. After each rain the mole reopens his burrows and frequently makes new ones. In a few hours after a rain, or early on the following morning were the times they were most easily taken.

The first step towards capturing them is to approximately locate the point at which they are working. This was done by pressing in with the foot the freshly made burrows at intervals of from two to three feet. I would then retire some distance, or treat the burrow of another in like

manner. When time had elapsed sufficient for one to begin work again I cautiously approached the place where the burrow had been closed, as above described, and if he had begun to reopen the pressed-in places, or was making a new branch in his burrow it would be but a short while before he could be seen raising the soil above where he is at work. He must be approached with great care for the slightest noise or jar from the foot will alarm him. When one is located and evidences seen of his working, I creep to within two or three feet of where he is and thrust a long-handle shovel in the ground a few inches in his rear, and by an upward and forward motion bring him to the surface. By selecting the proper time (after a rain and in the spring of the year) they are in this way caught very readily.

C. L. NEWMAN.

CAMDEN—METEOROLOGICAL SUMMARY FOR 1893.

	Mean.	Maximum.	Minimum.	Rainfall.	Last Killing Frost.	First Killing Frost.
January	42.8	80	14	0.95	.....	.....
February	47.8	72	24	4.20	.....	.....
March	52.2	82	21	4.41	19th	.....
April	66.4	86	38	7.57	.....	.....
May	70.8	89	50	7.81	.....	.....
June	77.0	94	60	10 24	.....	.....
July	81.5	95	67	3.73	.....	.....
August	77.6	94	56	1.28	.....	.....
September	.....	.....	.....	2.64	.....	.....
October	61.4	88	35	0.65	.....	.....
November	47.4	82	26	6.65	.....	14th
December	47.2	74	20	1.98	.....	.....
Annual	.....	.....	.....	55.11	.....	.....

The above summary is taken from the "Department of Agriculture Weather Bureau Annual Report, 1893, of the Arkansas Weather Service, F. H. Clarke, Director, Little Rock, Ark."

Manures for Wheat on Sandy Loam Soils.

As wheat growing is not profitable at the present low price of wheat, it is not expected that wheat experiments will attract very much attention, especially in the eastern and southern parts of the State, where these experiments were made. Some of the experiments, however, were begun two years ago and at that time wheat was selling at very good prices. Most of the sandy cotton soils of the State, except the fertile bottom lands, do not produce good yields of wheat, unless properly prepared and manured.

Several manural experiments were undertaken to determine their value to increase the yield of wheat on the worn sandy cotton soils. The soil used in the experiment had ceased to grow wheat profitably several years ago and had since been cultivated in cotton and corn. The manures therefore had full opportunity for action. Wheat was sown on the soil the year before, following a crop of corn and cowpeas in the corn. The pea vines, though few in quantity, were turned under and they were the first crop, other than corn and cotton, that had been planted on the soil since wheat was last planted.

As might be expected from the lapse of time since the last wheat crop and from the pea vines turned under the soil yielded a very good crop. The yield was 12 bushels 52 pounds per acre. The experiments were divided by the soil upon which they were made into two parts. One series of plots was upon soil that grew wheat in 1892-93 and experiment wheat in 1893-94. The other plots were upon similar and adjoining soil that grew wheat in 1891-92, cowpeas in spring of 1893 and experiment wheat in 1893-94. The latter soil differs from the former in that a crop of

cowpeas grew upon it in the spring of 1893 between the two wheat crops. The cowpeas on the soil were used in the experiment as subsequently described. Following is the plan of the experiment on plots of one-tenth acre each:

WHEAT 1892-93 FOLLOWED BY EXPERIMENT WHEAT 1893-94.

Plots.

1. 40 bushels cotton seed applied per acre to wheat 1892-93.
2. Nothing.
3. 10 two-horse wagon loads horse manure per acre.
4. 150 pounds acid phosphate per acre.
5. 150 pounds kainit per acre.
6. 200 pounds gypsum per acre.
7. Cowpeas planted after cut wheat July 31, and vines turned under green October 10.

WHEAT 1891-92, COWPEAS IN SPRING 1893, EXPERIMENT WHEAT 1893-94.

8. Cowpea roots, stubble taken off, plot turned October 10.
9. Cowpea vines with pods on vines, turned October 10.
10. Cowpea vines with pods off vines, turned October 10.
11. Green cowpea vines with pods on, turned under green July 31.

All plots were covered alike with a growth of crab grass when turned October 10. Plot 11 was turned July 31, while vines and pods were green and it was not turned again but prepared for planting October 10 by plowing in the crab grass with a scooter. Some of the grass was dragged off and the plot may have suffered some from that and also from a few mature peas that came up and were dragged off in plowing and harrowing for planting.

Plot 7 was planted in cowpeas July 31, soon after the wheat was cut from it. And when turned October 10 the

vines were green and vigorous with no mature pods but some at all other stages.

Peas were planted on plots at the rate of 1½ bushels per acre in 2½ feet rows, except plot 7, which was planted broadcast.

Fertilizers were applied at turning of the plots October 10.

Fultz wheat was planted October 25 at same measure per plot and plowed in with a five tooth cultivator.

NOTES ON WEATHER AND GROWTH OF WHEAT.

Half-inch rainfall next day after planting wheat.

November 1, weather dry.

November 5, wheat beginning to germinate, but irregularly.

November 10, stand of wheat very good but needing rain.

November 20, weather dry and windy, light rainfall today.

December generally favorable, low temperature accom panied by snow but did not damage wheat. First appearance of benefit from manure.

January 22, pea manure plots and stable manure plots show an increased tillering and growth over other plots.

March 15, past fourteen days have been favorable and wheat has improved rapidly.

April 1, past two weeks of cold damaged wheat slightly where jointed. A marked difference appears in favor of stable manure and dry pea vines, with pods on vines. Plot of dry vines without peas and green vine plot and late planted pea plot are next best. Pea stubble plot ranks next. Plots of commercial fertilizers show no benefit. Neither does plot where cotton seed was applied to wheat last year.

April 20, above notes of April 1 remain same with an increase of difference between plots.

April 30, good rainfall.

May 2, windy weather for past week has made soil dry and hard.

May 5, all plots in full bloom and about the same stage. Good growth made in the last few days.

May 10, wheat growing, and grains forming.

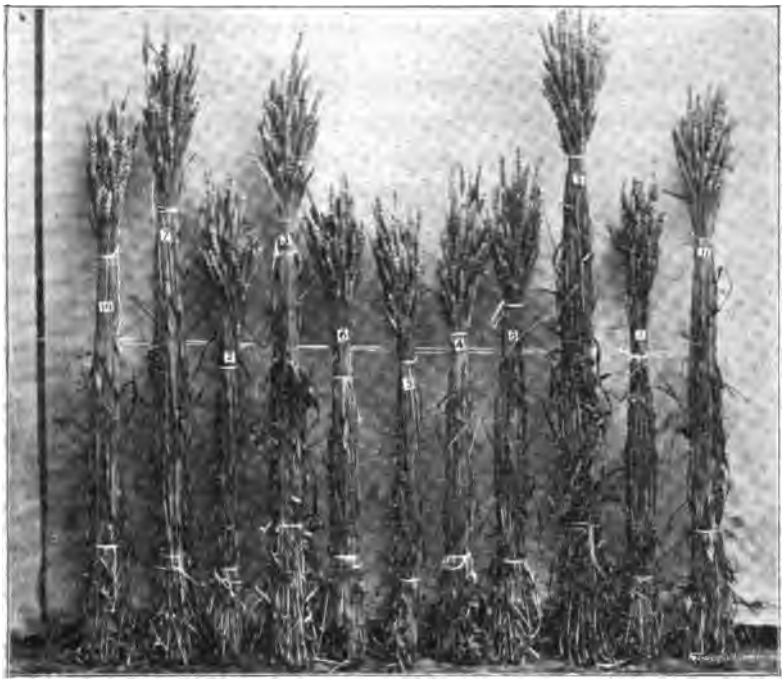
May 20, a little rain is needed. Wheat beginning to ripen.

June 6, wheat full ripe and all plots cut. Plot 7 slightly greener than others.

The season has been very favorable to wheat.

June 30, wheat threshed.

Height and growth of wheat on each plot is shown in the subjoined cut. Each sample of wheat contains 100 stalks. All the stalks of each sample were cut from the same place on each plot two weeks before harvesting. It was then unknown as to how the plots would yield and the fact that the growths as shown in the cut conform uniformly with the yields is very interesting.



MANURE EXPERIMENTS WITH WHEAT ON SANDY SOIL.

The number of each sample in the cut is the number of the plot upon which the sample grew.

TABLE OF YIELDS, 1893-94.

PLOT NO.	METHOD OF TREATMENT.	YIELD IN BUSHELS PER ACRE
	WHEAT GREW ON PLOTS 1 TO 7, 1892-93.	
1	Wheat, following wheat to ascertain the residual effect of 40 bu. cotton seed applied per acre, 1892-93	5 bu. 46 lbs.
2	Nothing	5 bu.
3	10 wagon loads horse manure per acre	15 bu. 16½ lbs.
4	150 lbs. acid phosphate	6 bu. 28½ lbs.
5	150 lbs. kainit	6 bu. 9⅓ lbs.
6	200 lbs. gypsum	7 bu. 53 lbs.
7	Peas planted July 31, turned under green Oct. 10	16 bu. 53 lbs.
	WHEAT ON PLOTS 8 TO 11, 1891-92, COWPEAS SPRING 1893.	
8	Pea roots	10 bu. 28 lbs.
9	Pea vines with pods on vines	18 bu. 10½ lbs.
10	Pea vines with pods off vines	15 bu. 30½ lbs.
11	Green pea vines with pods on vines—turned under green July 31	14 bu. 32 lbs.

The table is self-explanatory and shows fully the effects of the different manures and treatment. The yields of the plots are clearly in conformity with the notes on growth and with the growth as shown in the cut.

Wheat on all pea plots and stable manure plot tillered more than the commercial fertilizer plots and other plots. The increased yield in grain is due mainly to that and not to any increased length of heads.

The pea and stable manured plots appeared to have tillered more than twice as much as the others did.

Plot 10 yielded 1,160 pounds per acre of peas in hulls and the cost of picking them was 50 cents per hundred. This amount deducted from the value of the peas leaves a larger amount than the value of increase of wheat on plot 9 due to the peas left on the vines. Using the value of the peas now and that of wheat two years ago, 75 cents per bushel, in making the calculation.

Plot 1 shows but little residual effect from the application of 40 bushels of cotton seed per acre the previous year. The residual effect is of no practical value.

The difference of 4 bushels and 20 pounds between the two green manured plots 7 and 11 in favor of plot 7 is partially explained by the loss of the pea vines that came up and crab grass that were dragged off in preparing the plot for sowing. That loss could not have been avoided because of the rank crab grass. A turn plow could not be used because it would have brought up the pea vines that were turned under July 31. Part of the difference between the two plots may be due to the condition of the material turned under as many claim that the turning under of green matter in the summer at the south is not so beneficial as plowing under the same material when it becomes dry, or it may be due to the time of plowing. Plot 11 contained more formed pea pods when turned than plot 7 did when it was turned.

It is important to call attention to plot 7 as compared with plot 2. It yielded more than three times as much as plot 2. The increased yield was due to the pea vines planted July 31, after wheat was cut off the plot. Plot 7 had wheat following wheat with a crop of peas occupying the soil two and one-third months between the two wheat crops. The peas made as good growth as the spring planted pea plots but no pods were ripe when turned under October 10. The pea vines seemed to have restored the soil entirely from the effects of the previous crop of wheat. The yield of plot 7 was 16 bushels and 53 pounds, which exceeds the previous year's yield of plot 2, 4 bushels and 1 pound. The previous year's crop (1892-93) was the first wheat crop in several years and it followed corn with a few peas in corn which were turned under after ears were gathered. This season, however, was more favorable for wheat than that of last year.

It is important to know whether a crop of pea vines turned into the soil that was planted on the soil in June after wheat has been cut from it will restore the fertility of the soil and increase the succeeding wheat crop as much as turning under a crop of peas that was planted in the spring and occupies the soil the entire year. In the latter case wheat occupies the soil every other year and cowpeas the intervening year, while in the first case wheat occupies the soil annually and the cowpeas the time between the harvesting of one crop and the planting of the next, a period of three or four months. By comparing the yields of plots 7 and 9, it appears that there is but little difference between spring and summer planting, and that difference would not exist if the peas on plot 7 had been planted soon after the wheat was cut, thus giving them a growing period fifty-four days longer than they had. The extra period would have allowed the peas ample time to reach maturity and they would have made as much growth then as the peas did on plot 9. The

Wheat Planted at Different Dates.

Four plots of Fultz wheat were planted with the same quantity of seed to each plot at the following different dates: October 15, October 25, November 5, November 15.

YIELDS OF EACH PLANTING.

October	15—	Yield	per	acre	.....	6	bushels	25 lbs.
October	25—	"	"	"	.....	8	"	26 lbs.
November	5—	"	"	"	.....	8	"	45 "
November	15—	"	"	"	.....	10	"	52 "

The yields show a regular increase from first to last planting. The first plantings were slightly in advance in heading out, but the late plantings matured a little in advance of the first plantings and made less straw than the first plantings. Careful notes of growth and weather conditions were made during the entire growing period and from them the weather seems to have been the controlling factor in the difference in growth and yield.

April 15 a late spell of cold weather with ice came and doubtless did the early planted plots much harm. They were jointing at the time and some of the stalks were badly injured.

April 22 the first planted plots were taller and more jointed than the late planted plots. Likewise the early planted plots suffered most for rain in dry spells and from too much rain in wet spells and fired some. About the only practical information to be derived from this experiment is that the weather is a very important factor in controlling the yield of wheat especially on sandy soils; and that it is advisable not to plant too early for probable danger from insects and late freezes in spring; and that it is advisable not to plant too late, for early winter freezes may damage the stand and if no late April freezes come, the wheat might not make so much as if earlier planted because the season might be such as to delay matu-

rity and bring rust to damage. So, generally speaking for the locality of the Station, I believe about the last of October and the first of November would be the best time to plant, provided the soil was sufficiently moist. If the experiments were repeated for several years the seasons are so variable that conflicting results would doubtless be obtained.

Deep Breaking of Sandy Soil for Wheat.

Two plots were broken, one very deep while the other was broken as ordinarily done. The soil was same as all the soil on the Station, a sandy loam with good clay subsoil 18 inches from surface. The growth of wheat on the two plots did not differ at all. The yields differed 36 pounds grain per acre in favor of deep breaking. The difference, however, is too small for extra deep breaking to be of practical benefit on this sandy loam soil.

Varieties of Wheat and Seed from Different Localities.

In planting wheat in east and south parts of the State rust is an important question for consideration. A late wheat crop is more likely to rust than one that matures earlier. The fertility of the soil, the character of the soil, drainage, weather conditions and varieties exert more or less influence upon wheat rusting. Some varieties of wheat rust more than others, but efforts to find a rust-proof variety have so far been unsuccessful.

There is little difference in the yield of varieties that mature about the same time. A good hardy variety of some of the standard sorts is the best for general planting. A good hardy red wheat is generally regarded as less liable to rust. Fultz wheat is a hardy standard variety and has yielded well in variety tests at many of the Stations.

Seed of Fultz wheat was obtained from Michigan and Missouri, where they had been grown for more than three

years, and seed that had grown in the vicinity of the Station for four or five years were planted October 15 on plots to note their growth, period of ripening and yields. Michigan seed grew more and taller during the winter than the other two, but as spring advanced all differences disappeared. Wheat of the local seed lay flatter upon the ground than the others. All ripened at the same time and their yields were practically the same though there was a few pounds difference in favor of the local seed, with Michigan seed less than Missouri.

Grain Insects.

The principal insects that destroy stored wheat, corn, beans, peas, etc., are angoumois grain moth, black weevil, red grain beetle, bean weevil and pea weevil.

The latter two do great damage annually in the State to stored cowpeas. Other insects damage stored grain but not as much as those mentioned.

The best practical remedy for destroying these insects is to confine the grain in tight bins or barrels and set a saucer containing about 1 ounce of bisulphide of carbon on the wheat in each barrel, then cover the barrels tightly with sacks or boards for a day and all insects and other vermin will be killed.

Bisulphide of carbon is a clear, badly smelling liquid, and when unconfined quickly vaporizes and being heavier than air suffocates the insects as it penetrates all parts of the vessel containing the grain. The vapor soon escapes when the vessels are uncovered. Great care must be used in handling this substance as it is poisonous if breathed and is highly inflammable. It should not be used in a room that is artificially lighted or heated. It is inexpensive and can be bought at retail drug stores.

Grain or peas can be put in a pile on a tight floor and the open vessel containing the bisulphide of carbon set upon the

apex of the heap and the whole covered with blankets or sheets to confine the vapors within the heap of grain. Used in that way, about 1 pound to each ton of grain will be sufficient.

Some Grass Experiments on Clay Loam Soil at Fayetteville.

CHARACTER OF ROOT GROWTH AND PROPORTION OF ROOTS TO TOPS OF SOME HAY PLANTS.

The chief plants grown for hay in Northwest Arkansas are timothy, red clover, orchard grass, millet, and cowpeas. Red top is grown to some extent but does not rank in favor with the foregoing.

In comparing the yields of these plants subsequently to be described, an experiment was made to determine approximately the proportion of roots and stubble to tops and the character of root growth of those plants from one season's growth.

In February of 1893 a pit 4 feet deep was dug in the ground adjoining the plots of comparative yield. Five boxes 10x12 inches and 4 feet long were made of 1x12 inch plank, open at both ends and set upright in the pit. They were then filled in such a way that the soil occupied as near as possible the same position that it did in its original position in the pit. As the earth settled from rains the boxes were refilled with surface soil until all settling ceased. Seeds of the plants were then sown each in a separate box at the usual rate of sowing as near as it was possible to do, though the peas and millet were afterwards found to be too thick. Cowpeas and millet were sown later in the spring than the grasses and clover to avoid frost. Soil around the boxes was kept free from vegetation. The plants in each box grew as well as the same plants on adjoining plots. When the proper stages for hay were reached, the tops were cut off 1 inch above the top of the ground and put in cloth bags to

dry. The boxes were taken out of the pit and carried to a stream and the roots washed out on sieves of fine meshes. The roots were then put in cloth bags to dry. The tops and roots were thoroughly dry when weighed this June, and below are the weights in ounces for each of the five plants:

ROOTS AND TOPS OF HAY PLANTS OF ONE SEASON'S GROWTH.

GRASSES.	TOPS.	ROOTS.	RELATION OF ROOTS TO TOPS.	
			Tops.	Roots.
Orchard Grass..	2 $\frac{8}{32}$	2 $\frac{8}{32}$	100	100
Timothy.....	$\frac{24}{32}$	$\frac{20}{32}$	100	83
Clover.....	2	2 $\frac{4}{32}$	100	106
Millet.....	5 $\frac{28}{32}$	3	100	51
Peas.....	6 $\frac{28}{32}$	5	100	73

Character and Depth of Root Growth: Orchard grass roots: large, rough, and very long. Not wiry.

50 per cent roots between surface and 12 inches deep.
90 " " " " " " 20 " "
10 " " " below " " 20 " "

Timothy roots: Very small, smooth and wiry.

50 per cent roots between surface and 4 inches deep.
95 " " " " " " 6 " "
100 " " " " " " 12 " "

Clover roots: long and small. Not as large but stronger than pea roots. Tubercles were found on both new and old roots, and varied from size of a pea to smaller.

Quantity: Roots about same in first, second and third foot of soil.

Small roots were more abundant in first and second feet than in the third foot. Very few roots below 48 inches.

Pea roots: Large, succulent and *easily broken*, especially the small roots. Tubercles occurred in large numbers, especially on old roots. Some were as large as three peas

together. Few occurred below 2 feet; they were more abundant between 12 and 18 inches below the surface.

Quantity: Roots about the same in the second, third and fourth foot. Less in the first foot than in second or third. Many of the roots went down 5½ feet.

Millet roots: small and long, not succulent but wiry and tough.

80 per cent roots between surface and 12 inches deep.

15 per cent roots between 12 inches and 3 feet below the surface. Few roots below 4 feet deep.

The proportion of roots to tops and the character and depth of the roots of these plants are very interesting. They explain the reason why some exhaust the soil and suffer during drouth and that others do not rapidly if at all exhaust the soil and suffer but little during drouths. These facts accord with the experience of farmers.

Cowpeas suffer less during drouths than any of the others, while timothy suffers most of all from drouth, and stands the summers in East and South Arkansas only when sown on suitable soils and during favorable seasons, but here in Northwest Arkansas on clay soils and where summer drouths are not so long, it stands the drouths very well when *well set*.

Peas and clover get their food nitrogen mainly from the air through the microörganisms that produce the tubercular growths on their roots and the depth of their root growth enables them to get a large part of their mineral food from below the surface soil; therefore they do not exhaust the surface soil as other plants do that do not have the tubercles on their roots and that do not have a deep root system. The tubercular growths are beneficial to peas and clover and should not be confused with harmful root galls that occur on many plant roots. Peas and clover enrich the surface soil by adding to it plant food constituents which they have ob-

tained from other sources and are contained in their roots and stubbles. Soils are very much more enriched when the growth of clover and peas above ground are turned into the soil than when just their roots remain in the soil. Thus it is that peas and clover increase the yield of succeeding crops of cotton, corn, wheat, grasses, etc.

Comparative Growth and Yields of Some Hay Plants at Fayetteville.

As stated in the foregoing experiment the chief plants grown for hay in Northwest Arkansas are red clover, timothy, millet, orchard grass and cowpeas. They are named in order of their rank in area grown of each. Red top is grown to some extent and ranks about in favor with timothy, though timothy is preferred for feeding. Its yield of hay is light and it is not adapted to sowing on hill lands. Cowpeas are just being recognized in Northwest Arkansas for hay and manuring, while in East and South Arkansas it is the chief hay plant on poor soils. The soil and climate of Northwest Arkansas are very favorably adapted to the growth of grasses and clovers. Of the above mentioned plants timothy is more largely grown than any of the others, except red clover. The favorite way of growing those two is in mixture. Many persons grow timothy and like it better as a feed than they do orchard grass, because they are better acquainted with it than with orchard grass, but orchard grass is becoming more popular and it is better adapted to growing with red clover than timothy is.

Knowing the difference in the character of the growth, and especially the root growth of timothy and orchard grass, it was decided in 1893 to make a comparative test of their yields of hay and growth on *clay hill* soil. The other principal hay plants, red clover, millet and cowpeas were also included in the test. The soil upon which the plots

were located is clay loam, on hillside, with well drained clay subsoil. The surface soil was in good tilth and moderately fertile. Seeds were sown of the grasses and clover March 21. Cowpeas were sown later. A perfect stand was secured and all grew well as the season was very favorable. Millet, however, was killed by a frost and was not replanted.

NOTES ON GROWTH, 1893.

July 6—Clover plot made fine growth and was cut to-day.

July 15—Timothy, height 4 inches and tops mostly dead. It did not head out and was not cut.

Aug. 2—Orchard grass was cut. Height 10 inches. Cutting was delayed on account of dry weather and it being the first year of sowing.

Field peas planted May 28 grew rapidly and were cut to-day. Height 2½ feet. Grew vigorously notwithstanding the recent light rainfalls. First pods were full grown but not mature, too early for the best hay, but necessary to cut now to secure a second crop.

Clover: 10 inches high; not very thick; cut this date.

Aug. 7—Orchard grass began a rapid new growth in five days after cutting. Notwithstanding some dry weather has been prevailing, it is now looking green and vigorous.

Not a green blade of timothy to be seen.

Sept. 23—Orchard grass has grown slowly since the first of September. Height now 3 inches. Its growth before September has been dried up some by the September drouth.

Timothy: None to be seen on the plot.

Clover: 6 inches high, not thick. Remained green until September 14, then drouth checked further growth.

Peas: Second crop from stubble; height, 14 inches. The severe drouth checked their growth. Dry weather prevails here very regularly during the last of August and September and makes a second crop of hay from stubble very light; not worth saving for hay and is better plowed in the soil. Two crops of hay are also shortened by the short summer or growing season.

Oct. 7—Cowpeas cut second time. Yield very light.

Oct. 15—Clover 4 inches high.

Orchard Grass 3 inches high.

Nov. 1—Orchard Grass 3½ inches high; tips of blades killed by frost; would have afforded grazing since October 1, when rains began.

No signs of green blades of timothy.

Dec. ——Orchard grass and clover continue to grow but cold spells kill the blades back.

YIELD OF HAY PER ACRE, 1893.

Clover, first cutting, 3,000 pounds.

Clover, second cutting, 1,500 pounds, total, 4,500 pounds of dry hay.

Orchard grass, one cutting, 3,188 pounds of dry hay.

Timothy not high enough to cut.

Peas, first cutting, 3,375 pounds.

Peas, second cutting, 1,500 pounds, total, 4,875 pounds of dry hay.

Peas, duplicate plot, cut late and only one time; most pods ripe, 4,233 pounds of dry hay.

NOTES ON GROWTH, 1894.

January and February—Clover and orchard grass would come out during warm spells but would be killed back again by cold.

March 26—Clover and orchard grass began an early and rapid growth. Clover was 6 inches high and orchard grass 4½ inches when a severe cold killed the tops back to the ground. Temperature was 15 degrees.

April—Clover and orchard grass revived again soon after cold of March 26, but the temperature and moisture were not very favorable.

Timothy has shown but few live bunches. Notwithstanding the good stand of last year and that it was not cut, it succumbed to the drouth, except a few live bunches and they began a much later growth this year than clover and orchard grass.

May 23—Orchard grass and clover both cut for hay. Both were ready and were cut at same date and the earliness of the date should be observed.

June 1—Orchard grass and clover have both begun a new growth. Weather dry.

July 15—Rainfall has been insufficient for grass. Orchard grass 6 inches high. Clover cut second time to-day. It was thin.

At this date notes were prepared for this bulletin. The notes on growth of the several different plants show their growth during each month of the year and the effects on each plant of drouth and cold. The two annuals, cowpeas and millet, were not planted in 1894.

YIELDS HAY PER ACRE, 1894.

Clover—First cutting, 4,750 pounds dry hay.

Clover—Second cutting, 1,875 pounds dry hay.

Orchard grass—First cutting, 3,562 pounds dry hay.

Timothy—All died from drouth in 1893 except a few bunches.

The season has been too dry for best yields of hay. Very much more unfavorable than last season.

In the spring of 1892 a plot adjoining these was sown in orchard grass and the grass made a fine growth and one good cutting. In 1893 notes were made of its yield and growth, same as other plots, for comparing its yield the second year with the first year's growth of orchard grass plot planted in 1893. The season was very favorable and the plot yielded three cuttings: first cutting, May 20, second cutting August 2, and third cutting October 7. Total yield of the three cuttings per acre of dry hay was 9,106 pounds. Its yield this the third year at the first cutting May 23, 4,250 pounds of dry hay. This plot gives the experiment two orchard grass plots, one of two and the other of three years' standing, with yields and notes on growth for each year. An acre of orchard grass adjoining the plots but partly shaded by trees has yielded hay in like manner.

These experiments extend over sufficient time to be of practical value and for a comparison of the annual with the perennial hay plants and also for a comparison of the growth and yields of hay of timothy with orchard grass which is the main object of the experiment. Timothy died out the first summer, its root system was too near the surface of the ground. Though the season was not an unfavorable one, neither was the grass cut for hay. It might have done better if planted in the fall, and the same of orchard grass, but the latter is clearly more able to stand the drouth whenever planted, and therefore would furnish better grazing in the fall. The grasses were not sown late in the spring as it was March 21 when they were sown. If planted earlier, in this section, freezes would have killed them, and after March 21 they had time enough to make sufficient root growth to stand the dry weather and all but timothy did so. Timothy would doubtless have done better on valley soil, which would have been moister than that of the plots, and orchard grass would also have done better on

moister soil. Orchard grass possesses a much larger root system than timothy and its roots penetrate the soil to a greater area and depth. Consequently, it has a much larger territory from which to secure its food and water supply and that partially if not entirely explains its capacity to excel timothy.

Orchard grass, because of its nature, character and amount of growth is superior to timothy for grazing and its hay is also superior in food constituents to timothy hay. Though popular judgment favors timothy hay the preference, however, is not supported by chemical analysis and the experience of many practical farmers. From the average of several chemical analyses timothy has a nutritive ratio for feeding of one part of nitrogenous substance to fifteen and five-tenths of carbonaceous substance, while orchard grass has more nitrogenous substance in proportion to carbonaceous. It is one to eight and eight-tenths. Stock eat orchard grass as readily as they do timothy if not more readily.

Orchard grass is one of the best hay grasses on some soils for East and South Arkansas. Timothy will not succeed there at all except on the fertile and moist bottom lands and on fertile clay loams, and on such favorable locations orchard grass would excel timothy.

The complaint is often heard from those who grow timothy on their fertile bottom lands that it rapidly impoverishes the soil, which is correct.

Orchard grass is more permanent in this State than timothy and does not in any manner exhaust the soil like timothy, and it will grow on clay hillsides where timothy will not grow at all. Orchard grass is disposed to grow in tufts but that can be avoided by thick seeding and the soil can be set with it as easily as with timothy.

From the character of root growth and top growth of timothy and orchard grass and their nature and habits of

growth as noted in this experiment, it is evident that orchard grass should excel timothy in yield of hay and grazing, permanency and capacity to withstand drouths. And such are facts of experience as well as of experiment. Though timothy did not stand the summer during the experiment and furnish yields of hay to compare in quantity with the yields of orchard grass, it is a matter of experience in the State that where all things are equal timothy yields unequal to orchard grass.

Orchard grass starts growing very early in the spring and after mowing and after the fall rains it begins a rapid growth. It grows out during warm spells in winter and is therefore almost evergreen.

Considering the capacity of orchard grass to stand drouths, its adaptability to most all soils, and its yield of hay and good grazing furnished, there are none of the commonly cultivated grasses that seem equal to it for hay and grazing on the soils of the hills and valleys of Northwest Arkansas, and it deserves more attention from farmers in that section.

Cowpeas yielded profitably in the experiment. They are most always a sure crop for hay and when well cured are equal to any hay, and as a soil-improver they are equal to red clover. Cowpeas deserve more attention from farmers in Northwest Arkansas for hay and the pods for hogs to feed on. They can be planted after wheat and oats have been cut, and planted between June 20 and July 1, good hay will be made and it will be ready for cutting during the last of September, at which time there is usually but little rainfall to interfere with the hay. Planted in May one good crop of hay can be made and from the stubble a very good second crop will come which would be more profitable turned in the soil than cut for hay.

R. L. BENNETT,
G. B. IRBY, Assistant.

Stock Feeding.

So far as known all changes of whatever kind which occur in nature are in accordance with fixed methods. Under like conditions these changes are continually recurring. The purpose of the farmer is to bring about conditions suitable for the changing of inorganic to plant matter, and of plant matter to animal substance. A knowledge of these conditions and changes comes mostly from experience. A large part of the knowledge which we have of farming operations is the accumulated experience of centuries of more or less blind practice, having for its prime object the production of bread, meat and clothing. To arrive at a more definite understanding of the methods of change this experience has of late years been supplemented and extended by carrying on certain operations of the farm with unusual care in such a manner as to regulate with all possible certainty conditions which are known to influence the final results. Records have been kept of the details of these trials or experiments, and by comparing the records of different experiments and of different experimenters, men have acquired much definite knowledge of the conditions most suitable for the formation of plant matters, such as hay and grain, and also of those most suitable for the transformation of these substances into meat, butter and milk.

An effort has been made to give in the following pages something of the leading principles which have been ascertained concerning the feeding of domestic animals, in such a way that they may be understood and practiced by the farmers of this State who have neither the time nor necessary opportunities or a more extended study of the subject.

Feeding Standards.

The results of a considerable number of feeding experiments conducted in Germany have been embodied in a very concise form into what is commonly known as Wolff's tables or the German Feeding Standards. Since this table forms the basis of much work which has been done in recent years in the study of animal feeding, both in this country and in Europe, and is in fact the only feeding table in common use in this country, it is here given in full. While it embodies a considerable number of important principles, the limited number of experiments upon which it is based and the great complexity of the facts which it is designed to express, make many of the figures and numbers used in it, at best, only very approximately correct. However, if carefully used, it may form a useful guide for the feeder, helping him to greater economy and profit.

For the purpose of calling attention to certain facts which have not been pointed out as clearly as it seems important that they should be, a supplementary table is given showing the number of pounds of organic matter which will be digested, in passing through the animal, from each 100 pounds of total organic substance in the food. There is also shown in it the number of pounds of nonnitrogenous matter. This corresponds to the sum of the fats multiplied by 2.2 and of the carbohydrates shown in the main table. The reasons for this change are explained in the latter portion of this bulletin.

The German Feeding Standards.

Weights given are for 1,000 pounds of live-weight of animal per day. To obtain the amounts per head divide these weights by 1,000 and multiply the result by weight of animal to be fed.

	Total Organic Substance.	Nutritive (Digestible) Substance.			Total Nutritive Substance.	Nutritive Ratio.
		Albuminoids or Nitrogenous Matter.	Carbohydrates.	Fat.		
	lbs.	lbs.	lbs.	lbs.	lbs.	
Oxen, at rest in stall	17.5	0.7	8.0	0.15	8.85	1:12.0
Wool Sheep, coarser breeds	20.0	1.2	10.3	0.20	11.70	1:9.0
Wool Sheep, finer breeds	22.5	1.5	11.4	0.25	13.15	1:8.0
Oxen, moderately worked	24.0	1.6	11.3	0.30	13.20	1:7.5
Oxen, heavily worked	26.0	2.4	13.2	0.50	16.10	1:6.0
Horses, moderately worked	22.5	1.8	11.2	0.60	13.60	1:7.0
Horses, heavily worked	25.5	2.8	13.4	0.80	17.00	1:5.5
Milk Cows	24.0	2.5	12.5	0.40	15.40	1:5.4
Fattening Oxen, 1st period	27.0	2.5	15.0	0.50	18.00	1:6.5
" " 2d "	26.0	3.0	14 8	0.70	18.50	1:5.5
" " 3d "	25.0	2.7	14.8	0.60	18.10	1:6.0
Fattening Sheep, 1st period	26.0	3.0	15.2	0.50	18.70	1:5.5
" " 2d "	25.0	3.5	14.1	0.60	18.50	1:4.5
Fattening Swine, 1st period	36.0	5.0	27.5		32.50	1:5.5
" " 2d "	31.0	4.0	24.0		28.00	1:6.0
" " 3d "	23.5	2.7	17.5		20.20	1:6.5
Growing Cattle:						
Age. Months. — Average live-weight per head.						
2-3 — 150 lbs.	22.0	4.0	13.8	2.0	19.8	1:4.7
3-6 — 300 "	23.4	3.2	13.5	1.0	17.7	1:5.0
6-12 — 500 "	24.0	2.5	13.5	0.6	16.6	1:6.0
12-18 — 700 "	24.0	2.0	13.0	0.4	15.4	1:7.0
18-20 — 850 "	24.0	1.6	12.0	0.3	13.9	1:8.0
Growing Sheep:						
5-6 — 56 lbs.	28.0	3.2	15.6	0.8	19.6	1:5.5
6-8 — 67 "	25.0	2.7	13.3	0 6	16.6	1:5.5
8-11 — 75 "	23.0	2.1	11.4	0.5	14.0	1:6.0
11-15 — 82 "	22.5	1.7	10.9	0.4	13.0	1:7.0
15-20 — 85 "	22.0	1.4	10.4	0.3	12.1	1:8.0
Growing Fat Pigs:						
2-3 — 50 lbs.	42.0	7.5	30.0		37.5	1:4.0
3-5 — 100 "	34.0	5.0	25.0		30.0	1:5.0
5-6 — 125 "	31.5	4.3	23.7		28.0	1:5.5
6-8 — 170 "	27.0	3.4	20.4		23.8	1:6.0
8-12 — 250 "	21.0	2.5	16.2		18.7	1:6.5

Supplementary Table to German Feeding Standards.

	Total Organic Substance.	Digestible Organic Substance.	Indigestible matter in each 100 lbs. of organic substance.	Digestible Matter.	
				Nitrogenous.	* Nonnitrogenous.
Steers, at rest in stall	17.5	8.8	49.4	0.7	8.3
Wool Sheep, coarser breeds	20.0	11.7	41.5	1.2	10.1
Wool Sheep, finer breeds	22.5	13.1	41.6	1.5	11.2
Steers, moderately worked	24.0	13.2	47.9	1.6	12.2
Steers, heavily worked	26.0	16.1	38.1	2.4	14.3
Horses, moderately worked	22.5	13.6	39.6	1.8	11.8
Horses, heavily worked	25.5	17.0	33.3	2.8	13.8
Milk Cows	24.0	15.4	35.9	2.5	13.4
Fattening Steers, 1st period	27.0	18.0	33.3	2.5	15.1
" " 2d "	26 0	18.5	28.8	3.0	15.5
" " 3d "	25.0	18.1	27.6	2.7	15.4
Fattening Sheep, 1st period	26.0	18.7	28.1	3.0	15.7
" " 2d "	25.0	18.5	26.0	3.5	15.0
Fattening Swine, 1st period	36.0	32.5	9.7	5.0	27.5
" " 2d "	31.0	28.0	9.7	4.0	24.0
" " 3d "	23.5	20.2	14.0	2.7	17.5
Growing Cattle:					
Age. Months. — Average live-weight per head.					
2-3 — 150 lbs.	22.0	19.8	10.0	4.0	18.2
3-6 — 300 "	23.4	17.7	24.4	3.2	15.7
6-12 — 500 "	24.0	16.6	30.9	2.5	14.5
12-18 — 700 "	24.0	15.4	35.9	2.0	13.4
18-24 — 850 "	24.0	13.9	41.1	1.6	12.1
Growing Sheep:					
5-6 — 56 lbs.	28.0	19.6	30.0	3.2	17.4
6-8 — 67 "	25.0	16.6	33.6	2.7	14.4
8-11 — 75 "	23.0	14.0	39.1	2.1	12.5
11-15 — 82 "	22.5	13.0	42.3	1.7	11.3
15-20 — 85 "	22.0	12.1	45.0	1.4	11.1
Growing Fat Pigs:					
2-3 — 50 lbs.	42.0	37.5	10.7	7.5	30.0
3-5 — 100 "	34.0	30.0	11.8	5.0	25.0
5-6 — 125 "	31.5	28.0	11.1	4.3	23.7
6-8 — 170 "	27.0	23.8	11.9	3.4	20.4
8-12 — 250 "	21.0	18.7	11.0	2.5	16.2

* The Nonnitrogenous matter is the sum of the Carbohydrates and of the Fat multiplied by 2.2.

Some Chemical Terms Used in Stock Feeding.

In comparing the food values of different substances by chemical *analysis, three different forms or groups of the chemical compounds which make up a food are considered—crude protein, the carbohydrates and the fats. Crude protein consists of a considerable number of substances most of which are quite similar to the albumen or white of eggs. All compounds of that group contain nitrogen and for that reason are frequently called nitrogenous substances in distinction from all other organic matter present. This for convenience may be all grouped together and referred to as *non*nitrogenous organic matter. It comprises the carbohydrates and the fats.

In seeds and grains the so called fat is for the most part similar to the fat of animals, but in grasses and other coarse fodders it includes considerable and varying quantities of coloring matters and other impurities which are probably of little or no value as food. The carbohydrates include, among other things, what is frequently known as crude fiber and which consists mainly of cellulose. The lint of cotton is nearly pure cellulose, as also are the long fibrous threads which may be drawn out of a partially decayed cornstalk. The remainder of the carbohydrates consists of starch, sugars and other substances, some of which may be readily changed into sugar during digestion in the animal body, and some of which are indigestible and which consequently do not supply nourishment to the animal. These latter substances together with such portions of the crude fiber as are not digested serve to give bulk to the food, and are, in suitable quantities, beneficial in that way for certain classes of animals.

The ash of plants, while important in furnishing mineral salts to the animal, is contained in most foods in such unnecessarily large quantities that usually no account is taken of it in considering the food value of any substance.

*For further explanation of terms used in fodder analysis see Bulletin No. 24 of this Station.

What the Animal Requires of its Food.—The muscles or lean meat of animals is for the most part, like the crude protein of plants but in a larger degree, similar to the albumen of eggs. In all animals which live entirely on vegetable matter the origin of this material, both during growth and to supply the waste which is continually going on, is the crude protein of plant matter. This also is the source of the caesine and other albuminous substances which occur in the milk of dairy animals. While hay and grain plants derive their nitrogenous matter from inorganic material supplied to them from the soil and air, farm animals cannot build it up out of crude material. It must be supplied to them in the form of albuminoids. For the most part these albuminoids come directly from the crude protein of plants. They are equally serviceable if derived from the flesh, milk or eggs from other animals.

Besides the albuminous substances there are also found in the animal body fats and substances similar to the sugars and starch which occur in plants. The albuminoids or protoplasm of living flesh is continually undergoing change or a series of changes. In fact it is this change which constitutes the life of the protoplasm. To enable this change to go on it is necessary that some form of nonnitrogenous matter be present at the immediate point of action. These substances are carried from one part of the body to another by means of the circulation of the blood. They have their origin in the food consumed and may be derived either from the nitrogenous or the nonnitrogenous matters of the food. When obtained from nitrogenous matter it is apparently at the cost of a certain amount of energy or labor and they cannot be derived entirely from that source without so great a disarrangement of the animal system as to speedily result in death. They must be derived in part from the nonnitrogenous matters, the starch, sugars, fats, etc., of the food, or from non-

nitrogenous substances which have been previously stored in the body, generally in the form of fat.

Since the animal body requires these two distinct classes of foods, the question has arisen as to the proportions in which they should be combined to give the most satisfactory results in feeding animals for profit. The results of numerous feeding experiments show that when the proportions are other than the most suitable, larger quantities of food will be required to produce a pound of increase in weight or a given quantity of butter or milk than would be necessary under more suitable conditions. It has also been found that the most suitable proportion differs according to the age and kind of animal and the purpose for which they are fed. Further, by combining foods of different compositions according to the proportions of nitrogenous and nonnitrogenous matters which they contain, it is possible to obtain foods suitable to give desired results.

No food in common use for the feeding of farm animals is wholly digestible and the digestibility of both the nitrogenous and the nonnitrogenous matters of different foods varies greatly. Only such portions of a food as are digested contribute to the nourishment of the animal. In considering, then, the relative proportions in which the two classes of food material should be combined the comparisons are based upon those portions which are digestible. In the right hand column of the table given on a preceding page, under the head of *Nutritive Ratio*, may be found the number of parts of digestible nonnitrogenous matter which should be present to each part of nitrogenous matter in foods considered suitable for the class of animals named in the first part of the corresponding line. In other words, the table indicates that, in the food for milch cows, for example, there should be 5.4 parts of digestible nonnitrogenous matter for each one part of digestible nitrogenous matter, while the food suitable for

keeping resting steers in a condition neither to gain nor to lose weight need not contain more than one part of digestible nitrogenous matter to each twelve parts of digestible non-nitrogenous matter. In either case it is assumed that the proper quantities of food, as shown in other columns of the table, will be given.

Variations from the proper nutritive ratio are at the expense of an increased consumption of food for yields returned. How wide may be the limit of variation without seriously affecting returns is unknown. That the best ration for a given class of animals is to a certain extent uncertain and varying is apparent no less from a careful examination of the feeding table than from a knowledge of the method by which it is constructed or a consideration of the problem to which the figures are supposed to give answer. As before stated these figures are only approximately correct and are given only because they are the best answer which has yet been found to the problem which is before us.

While all animals require nonnitrogenous as well as nitrogenous matters in their food, the younger the animal, up to maturity, the larger should be the proportion of digestible nitrogenous matter which the food contains. Varying the proportions influences not only the amount of gain from a given quantity of food, but also the quality of the increase produced. A diet for young animals containing an excess of nonnitrogenous matter will produce a carcass of excessive fat and probably an animal of stunted development, while an excess of nitrogenous matter for older animals will delay the bringing of the animal into a condition suitable for the butcher. In other words, a highly nitrogenous diet increases in an animal the growth of frame and flesh, while a highly carbonaceous or nonnitrogenous diet contributes more largely to the formation of fat.

Closely related to the present branch of the subject is the relative increase in live weight for a given weight of food consumed by animals of different ages. It is almost the universal experience of feeders that the younger the animal the greater will be the gain for a given weight of food consumed, and it is now quite generally believed that the profitable feeding of hogs for market ends when they have reached a weight of 175 to 200 pounds. It is also argued that steers are most profitable when so fed as to be disposed of at an age of from eighteen to twenty months. This, however, does not accord with the prevailing methods of growing steers upon the ranges of Arkansas and presupposes the most painstaking and watchful care of the animal from birth to time of sale. It is not intended to here imply that such is not the most profitable method of feeding, even under conditions prevailing in this State, but rather is offered as a suggestion as to a method likely to produce good results.

Of those substances commonly used as food for domestic animals, two distinct classes are recognized—the coarse fodders and the concentrated foods. Generally speaking the coarse fodders are those which contain a considerable quantity of woody matter (crude fiber), notably from 20 to 30 per cent or more of their dry matter. The concentrated foods contain comparatively little. Nearly always less than 10 per cent. This crude fiber is in a large measure an index to the bulkiness of the food. Notwithstanding that a certain portion, frequently more than half, of the crude fiber in a food may be digested by the animal to which it is fed, the amount present is a rough index of the amount of that food which will pass through the animal undigested. In the concentrated foods the proportion of indigestible matter to the crude fiber is much larger than in the coarse fodders. In all cases it is larger than the amount of crude fiber present.

Owing to the peculiar structure of their digestive canals different kinds of farm animals require food of different degrees of concentration or bulk. Thus, horses doing little or no work should have a comparatively bulky and unnutritious food to keep them in suitable condition. Store cattle and sheep will require similar but somewhat less bulky foods. These same animals when at work or fed for fattening will require a food of nearly equal bulk but containing a larger quantity of nutritious or digestible matter. The structure of the digestive tract of the hog makes concentrated food only, adapted to its use and nothing more bulky than young and nutritious green clover or similar material is of value to it. With all animals the bulkiness of food best suited to them increases with age. Very young animals require food of little bulk while the food of horned cattle of mature age may contain from 40 to 50 per cent of indigestible or effete matter.

Stock Foods.

The composition and digestibility of foods of the same kind vary within certain limits according to the conditions under which it has grown; the stage of development at which it has been harvested; and the thoroughness and success with which it has been cared for and preserved. Of these variations, that which is most regular, and, in fact, the only one concerning which definite information can be given, is the stage of development at which the crop is harvested.

It is almost an invariable rule in all plant growth, that the younger the plant the greater will be the *proportion* of nitrogenous substance present in its dry matter. The same is also true of the ash ingredients. Though the absolute amount of these substances in the plant or the number of pounds per acre increases with the age the number of pounds in each 100 pounds of the dry matter of the harvest steadily decreases. At the same time there is an increase of the

number of pounds of nonnitrogenous matter per acre as well as the amount in each 100 pounds of total dry matter harvested. The above statements as to total amounts, do not take into account losses which may occur in the latter stages of growth by the falling of leaves and other mechanical means.

As the plant increases in age there is an increase in both the relative and absolute amount of woody fiber in the roots, stems and leafy portions of the plant. In the seeds while there will be an increase of the total amount of fiber there will generally be a slight decrease in the number of pounds in each 100 of the total product as the plant ripens.

Not only does the composition of the plant change with increased age, but the digestibility also decreases. Especially is this true of the shrubby portions of the plant, the stem and the leaves. While the proportion of matter which will be digested or dissolved by the animal to which fed, decreases with the age of the plant, it does not follow in all cases that the nutritive value of a given weight of the food will decrease in like manner. In some instances much of the matter present which would be dissolved may be in a crude state of combination quite unfit for the use of the animal, but which would by further growth of the plant be changed into substances of far greater food value. This seems to be true of immature root crops such as turnips.

The time commonly adopted for the harvesting of crops for hay is when a majority of the plants are in bloom. Though plants cut at this stage contain a less number of pounds of digestible matter in each ton of dry matter harvested than when cut earlier, the total number of pounds yielded per acre will generally be greater. After bloom as before, the total weight of matter continues to increase and the digestibility of the harvest to decrease. Which change will generally be most rapid is as yet an unsettled question.

When carefully preserved the mere drying of a grass does not decrease its digestibility, or in other words its food value. The difficulties which are commonly met in the curing of grass for hay makes the food value of that article, generally, somewhat less than would be that of an equal weight of dry matter in the same grass fed fresh. To what extent there will be loss of food material in this way depends upon the success of the curing operation. The relative qualities of different hay cut from the same kind of grass at the same stage of development can generally be ascertained by the farmer only by experience in handling and feeding.

The coarse fodders most commonly used in Arkansas are hays of the various grasses and certain leguminous plants (among which are clover, cowpeas, alfalfa and peanuts), fodder from the corn plant and cotton seed hulls, besides straw of wheat and oats.

For practical feeding purposes the food value of hay from all the tame grasses may be considered equal, and according to chemical analysis prairie hay does not fall greatly below them. It is eaten with somewhat less relish and common experience seems to be that it is less nutritious. So far as known no experiments have been made to determine its digestibility. It is highly improbable that the food value of this article is so greatly below that of timothy hay as would be indicated by the current prices. Hay from all the leguminous plants is comparatively rich in nitrogenous matter and when well cured is, as a single article of diet, superior to hay from the grasses. It will require somewhat less nitrogenous concentrated foods when they are given in addition to the coarse fodder. It is not well adapted as a food for horses because of its comparatively coarse stemmy nature and the injurious dust which arises from such as is not well cured.

One difficulty in using cowpeas and peanut vines for hay has been that of curing, because of the large quantities of water contained in the thick stems. Opportunities for remedying this are now offered in the way of the stack frame described in Bulletin No. 27 of this Station.

Corn Fodders.—If the stalk, leaves and husk of the corn plant could be properly preserved they would in many instances supply animal nutriment quite equal in quantity to the grain which it produces. Various means are resorted to for securing this fodder for use and the great question involved is the economy of the different methods practiced. The costs and returns are continually varying and only some general features of the question can be here pointed out.

The cutting of corn for fodder involves not only the cost of cutting and storing the fodder, but also a somewhat increased expense of gathering the grain from the stalk. There is also a greater or less loss of grain by this method of gathering fodder which varies with the time of cutting. It has been found that cutting the corn when the kernel is in milk may diminish the yield of grain one-half; if cut when in dough the yield of grain may be diminished one-third. Probably it cannot be cut at any time sufficiently early to be serviceable as fodder without diminishing the yield of grain to some extent. Estimates made by various Experiment Stations indicate that when comparing the cost of harvesting the fodder and the loss and increased cost of gathering the grain there is in some instances a loss and in others a considerable profit by cutting the corn for fodder. It is evident that the chances for gain must be greater the nearer the corn is to ripeness, presupposing of course that it is not so far ripened as to allow the drying of the entire stalk and its leaves. Generally speaking the husks and lower leaves should have become brown.

An item of importance in this connection is the apparent necessity in warm climates to allow the corn to remain upon the standing stalk until well dried and all danger of moulding is past. The method of gathering the ears in such a way as to secure a considerable part of the husk results in the saving of a weight of fodder equal to nearly one-half that of the dry leaves, and according to the best data at hand they are nearly equal, pound for pound, in food value.

By pulling fodder there is in many instances a loss of more than one-tenth of the grain and when the cost of gathering the fodder is taken in connection with this there seems to be more frequently a loss than a gain in money value of fodder harvested in this way.

The only trials on record show the actual food value of the leaves to be even less than that of an equal weight of fodder obtained by cutting that portion of the stalk above the ear. A majority of recorded trials show little or no loss of grain by this latter method of securing fodder, and in a trial made at this Station the weight per acre of dry fodder was about equal to that of the pulled leaves. As in the cutting of the stalk the loss of grain if any will vary with the time of gathering, and since the top is the last portion of the plant to ripen the harvesting may be delayed longer than would be profitable either with the cutting of the entire stalk or the pulling of the leaves.

All things considered it appears that when it is desired to obtain a quantity of corn fodder in connection with the grain grown in this State the most economical way is to cut the stalk above the ear after the kernel is well dented and the lower leaves are dead. It should then be allowed to dry thoroughly, tied in bundles and stored in the barn or in stacks. If well preserved, stock eat it with a relish, and if thoroughly dried it will contain pound for pound more digestible nutritious matter than the average quality of timothy

hay and even more than clover hay. The latter, however, contains a much larger proportion of nitrogenous matter.

Ensilage.—A method of preserving coarse green material which has been applied with special success to storing of corn fodder is that of making into *silage* or *ensilage* by packing airtight in pits or bins known as silos. These silos are either underground cellars with cemented walls or buildings above ground having specially prepared walls made airtight by use of building paper and tight board coverings, usually on both sides of the studding, leaving a dead air space between. The inner of these is generally coated with hot coal tar. The silo may be either circular or rectangular and should be higher than broad. The circular form is preferred because cheaper and stronger.

The favorite method of storing corn fodder in the silo is to cut it into lengths of about one-half inch. It is then spread evenly over the bottom or the preceding layer and packed by thorough tramping, especially about the edges. The practice of filling in from two to three feet on each of several succeeding days has met with much favor. Good results have sometimes been secured by putting corn fodder into the silo at its full length, but this method has several objections. The practice of weighting the stored fodder heavily with stones or other weights is now almost entirely replaced by using a light covering of hay or straw protected by a layer of boards. Tarred paper is also sometimes used while frequently there is no covering whatever. In the latter case it will generally be necessary to reject the upper layer of a few inches before feeding.

The corn for silage may be such as is grown for the ordinary method of harvesting, but it is generally planted somewhat thicker. It should not be so thick as to prevent earing freely. The time of gathering is when the kernels are glazing.

When equal care in preserving is exercised in colder climates the loss of dry matter of fodder preserved in the silo is about equal to that which occurs when the corn is cut and cured in stacks. In this State the heavy fall rains would cause a greater loss by the latter method. The results of several experiments indicate that the food values of the dry matter of fodder preserved by the two methods are about equal. The ensilage fodder requires less handling before being stored and is more convenient for feeding. It is relished by cattle and has apparently no injurious effect upon milk or meat produced.

Other green fodders have been stored successfully in this way. The practice of ensilaging corn fodder and leguminous plants together, thereby giving a food of a more suitable nutritive ratio, has been suggested with reason, but at present there is little experimental evidence concerning the practice. Ensilage from clover is believed to be inferior to that from corn. The coarse running nature of the cowpea vine is a serious obstacle in the way of its use for ensilage.

Speaking of fodders in general, the relative economy of storing green in somewhat expensive silos or of drying and preserving in the usual way is still a very open question. The almost universal approval which corn ensilage has received wherever used is a strong argument in its favor. It is especially adapted for the use of those feeding large quantities of cattle either for dairy or beef purposes. It is too costly for the average small farmer and any special use as a succulent food which ensilage may have in winter may in such cases be obtained by growing rye fodder and crimson clover, or such root crops as turnips and mangel-wurzels.

Cotton Seed Hulls.—Another material which has of recent years come into somewhat general use in this State as a coarse fodder is cotton seed hulls. Especially are they used in abundance in feeding about cotton oil mills where they are

fed in connection with the cotton seed meal. They seem well adapted as a dilutant for this highly concentrated food material and are probably better suited for that purpose than almost any other substance which could be obtained—certainly better than any which could be obtained in the vicinity where used. The composition is very similar to that of wheat straw and it has been found that about two-fifths of the total dry matter of the hulls is digestible. Of this by far the largest part is nonnitrogenous matter, so that when fed with cotton seed meal in the proportion usually given at the mills the nutritive ratio of the entire feed is not far from 1:6.

During the past winter cotton hulls have been offered for sale in the vicinity of some of the large mills for about 10 cents per bale of 100 pounds. As a food they do not seem so well adapted for any other purpose as for use with cotton seed meal.

Straw.—Of all the grain straws, oats is probably most suitable for food, partly because it is usually cut before the grain is entirely ripened and partly because it is, even when fully ripened, less harsh and woody and contains a somewhat larger proportion of nutritious matters than the other straws. When properly preserved, straw may prove a valuable supplement to more concentrated foods and may even contain sufficient nutriment to answer as the entire food for animals which it is not desired to work or fatten. When cut at or near bloom oats make a valuable hay which approximates in composition to that from timothy. Cut at this stage rust of the straw may be largely avoided, but when early cutting is not necessary for prevention of this disease there will probably be greater gain to allow the grain to mature.

The concentrated stock foods in most common use in this State are corn, cotton seed, wheat and oats, or by-products from manufacturing processes in which these seeds and grains constitute the raw material.

Cotton Seed.—Several Experiment Stations have made investigations as to the feeding values of cotton seed both for fattening and dairy purposes. The raw seed has been successfully and profitably fed in connection with a moderate amount of hay for both. Boiling, steaming and roasting the seed have been tried. They have been found to lessen the laxative effect somewhat and in some cases have apparently given more profitable returns than the raw seed. Roasted seed has been found to be much less digestible than the raw seed. All things considered it seems to be the universal sense that feeding the seed raw is preferable to cooking them by any of the foregoing methods.

Cotton seed seem to have no injurious effect upon the health of cattle, and if fed in moderate quantities little injury is done to the quality of the butter and milk of the animals fed. An apparently almost universal effect is to produce butter of a light color. Cotton seed and its products are thought to have a beneficial effect upon the rising of cream and have been found to decidedly increase the melting point of butter. The flesh of animals fattened on cotton seed meal and hulls is apparently not inferior to that from corn fed animals.

Neither cotton seed nor cotton seed meal are adapted for the feeding of hogs. In several instances reported they have resulted in the death of the animals fed. They are, however, reported as being sometimes used with good results.

Cotton Seed Meal.—The value of cotton seed meal as feed for cattle is extensively recognized, as is apparent from the large quantities used and the almost universally good reports which are given of it. When other foods are abundant it is especially valuable for increasing the nitrogenous matter in the rations fed, and where other foods are scarce it may be made to take their place to a large extent. When

allowed to become rancid it is unfit for feeding as it is liable to injure the health of the animal. This condition is readily recognized by the odor and dark color. Having once become rancid the material should be used for fertilizing purposes only.

On the average each 100 pounds of cotton seed as divided in the oil mills will yield the following weights of products:

Products.	Pounds.
Meal	37.5
Oil	12.5
Hulls	48.9
Lintel (short lint from reginning)	1.1

Cowpeas when harvested and threshed are undoubtedly a highly valuable concentrated food, especially when ground into meal. They are a highly nitrogenous food, having a nutritive ratio of 1:3.1, and are well adapted for feeding with starchy foods such as corn. The difficulties of their use are those of gathering and threshing and their consequent high price for seeding purposes. They are therefore not used for food to any great extent except in connection with the vine upon which grown or when gathered from the field by hogs.

Oats.—By themselves, oats are decidedly a horse food. For cattle they are valuable for grinding with corn or wheat to increase the bulk of the meal. The difficulties of securing well cured bright oats is greatly against their use for horses in this State, as rusty and mouldy oats are liable to prove injurious to the health of the animal even when moistened with water. Although containing more woody fiber than any other of the grains they are a highly nutritious article of diet being rich in both nitrogenous matter and oil.

Corn.—Probably no other commonly used concentrated food has superior fattening qualities to corn. It is decidedly a carbonaceous food having but one part of nitrogenous matter to about nine parts of nonnitrogenous matter. It is

especially adapted for the fattening of hogs, but has too little nitrogenous matter and ash to be used as an exclusive feed for hogs under six months of age. In fact a large number of experiments seem to prove that better results will be obtained in feeding animals even of more mature age upon a mixture of more nitrogenous substances with corn. It is, however, to be borne in mind in this connection that cotton seed meal is not a suitable food for hogs. When the food of hogs consists largely of corn they should have free access to charcoal, ashes or ground bones to give necessary mineral material for the formation of bones and other requirements of the body.

As a food for horses corn should be free from mouldy or unsound ears as such are now believed to be the cause of "blind staggers," and aside from that are liable to prove injurious to the general health of the animal. As a food for cattle, where it is possible, corn should be ground and mixed with other foods, for which purpose oats, cotton seed meal and bran, or ship stuff, are well suited.

Corn Bran.—Of recent years millers have come to bolting corn as it is ground, obtaining therefrom corn flour and corn bran as the resulting products. The kindness of Mr. B. F. Johnson has made it possible to present the analysis of a sample of Kansas corn and the products of its bolted meal together with the proportions of each obtained. The miller expressed the opinion that the proportion of bran was larger than will frequently occur. Ten bushels of corn were ground with the following results expressed in per cent of the entire weight:

Flour	86.8
Bran	12.5
Loss	.7

Composition of corn and its resulting flour and bran:

	Corn.	Flour.	Bran.
Water	14.30	14.65	12.27
Ash	1.12	.80	2.38
Crude Protein	9.28	8.88	10.75
Fat	3.84	3.18	8.52
Crude Fiber	2.30	1.30	8.85
Nitrogen free extract	69.06	71.19	57.23

One of the features most noticeable in this analysis is the high proportion of oil in the bran. There is also in the bran a higher proportion of protein, fiber and ash, but less water and much less starchy matter. This analysis shows corn bran to be nearly equal to wheat bran, but from its husky nature it would hardly be very palatable for use as a single food. It is also a less nitrogenous food than wheat bran.

Wheat.—The low price of wheat during the last few years has led to the use of that article to a considerable extent as a food for domestic animals. It is a highly concentrated food, being rich both in starch and in nitrogenous matters. The nitrogenous matter, the greater portion of which in this grain constitutes what is commonly known as gluten, forms on being wet with water an elastic gummy mass which if fed to animals in a raw condition and without intermixture of other foods, is exceedingly difficult of mastication and digestion. For these reasons it must be used with great care. If fed to horses or cattle it should be diluted largely with bran or oats or coarsely ground and sprinkled upon moistened coarse fodder, straw or hay, which has been cut into short lengths as in a feed cutting box.

Wheat is meeting with much favor as a food for hogs, either when ground or fed whole and it is sometimes extensively fed without threshing. The Experiment Stations of Oregon and South Dakota report gains of about twelve pounds of live weight per bushel of wheat fed, while numerous individual farmers writing for agricultural papers report somewhat

greater increases and returns for wheat fed than would accord with these figures. Wheat is especially adapted as a food for young pigs and breeding sows—animals which require a considerable proportion of nitrogenous matter in their food.

Wheat screenings frequently contain considerable but ever varying quantities of food material. The value will of course increase or decrease largely in proportion to the amount of wheat or broken kernels present. Foreign seeds may contain much nutriment but should either be crushed before using or fed in such a way as to make certain that all are consumed and their vitality destroyed.

Mill Feeds.—Other bye products from the milling of wheat are bran and shipstuff, also called shorts and feed middlings. The composition of both of these articles varies greatly according to the kinds of wheat used and, more especially, according to the special method of the mill in which ground. In many mills, especially the smaller ones, they are run together as "mill feed." They consist of the hull or outer portion of the wheat together with a considerable quantity of that portion of the berry lying immediately beneath, besides the germ or sprout producing portion of the berry, and contain a considerable larger proportion of nitrogenous matter, ash, oil and woody fiber than the entire grain.

Shipstuff will generally contain a somewhat larger proportion of the center of the berry and consequently more of the starch than will the bran. It will also contain nearly equal or slightly larger quantities of nitrogenous matter and oil but less crude fiber and ash. The constituents of shipstuff are also frequently more digestible than are those of bran. Laying aside any reference to the whole wheat berry or its meal, it may be safely asserted that so far as mill feeds go they will be of greater value the greater the proportion of the interior or flouring portion of the kernel which they contain.

Especially is this true when they are used as the entire or chief article of food for pigs, or as the only concentrated food for animals receiving hay rich in nitrogenous matter, such as pea vine or clover hay. The large proportion of woody fiber and its consequent bulk, make coarse bran unsuited as a food for fattening hogs except when fed with a considerable larger proportion of corn or corn meal. On the other hand shipstuff wet with either water or milk seems especially adapted as a food for young and growing pigs. The same would probably be true of the entire mill feed (bran and shipstuff) mixed with a considerable proportion of dark or low grade flour. Bran and shipstuff are well adapted as a concentrated food for milch cows especially when mixed with corn meal.

Compounding Food Rations.

The Requirements.—Without at present making any reference to cost of material, there are, in the selecting of suitable foods for domestic animals, three important points to consider: The amount of nutritive matter consumed; the bulk of the food, and the relative proportions of the nitrogenous and nonnitrogenous matters.

It will be seen from an examination of the German Feeding Standards that all of these conditions vary with the age and kind of animals and the purposes for which fed. The amount of digestible or nutritious matter in different kinds of food has been ascertained by means of experiments, in which both the food eaten and the indigestible excreta have been carefully weighed and analyzed. However imperfect the results of such experiments must necessarily be they have given a guide which may be of great service to those who are feeding for profit.

Apparently the most definite method of conveying information as to the comparative bulk of food is by comparing the amounts of indigestible or effete matter which they contain, for in general those foods which have a large proportion of crude fiber contain also a large proportion of indigestible matter. In the supplementary table to the German Feeding Standard, given on the page which follows them, it may be seen that while the total amount of organic matter and the amount of digestible organic matter which should be given daily for each 1,000 pounds of live weight of the animal, both vary for different groups of animals, they do not vary in the same manner and to the same extent. While in some instances the amounts of total organic matter remain the same, the amount of nutritive substance, or, in other words, the amount of digestible matter, varies several pounds. Accordingly in the third column of this supplementary table is shown the number of pounds of indigestible organic matter which should be found in each 100 pounds of total organic matter contained in the food. This is seen to vary from less than ten to nearly fifty pounds. It may be also seen that those rations containing the largest proportions of indigestible matter are for such animals as common experience teaches us are best suited to the consuming of bulky fodders.

In the right hand column of the table of Arkansas Food Material, given on the last pages of this bulletin, may be found the number of pounds of indigestible organic substance in each 100 pounds of the total organic matter in the food. An examination of the table shows that in the more concentrated foods, the grains and seeds or their products, the number of pounds of such indigestible organic matter is very notably less than in hay, straw, etc. From the foregoing facts we have a guide as to the relative amounts of coarse and of concentrated foods which any selected class of animals should receive.

The importance of having a food of suitable nutritive ratio or containing a suitable proportion of digestible nitrogenous matter as compared with the amount of digestible non-nitrogenous matter has already been pointed out.

The Table of Stock Foods.—The table at the close of this bulletin contains information, compiled from various sources, concerning certain foods common to Arkansas, so arranged as to be convenient for use in combining rations suitable for different classes of animals, in accordance with the principles which have just been pointed out and which are embodied in the German Feeding Standards.

In the table the proportions of ash and water are given though they have little bearing upon the main points in this question. A portion of the ash is digested by the animal and in none of the substances given is the amount of indigestible ash so large as to materially increase the amount of effete matter in the food. The water in food has little effect upon the animal except in those rare instances where the proportion is so very large as to require the consumption of an excessive amount in order to give the animal a sufficient quantity of digestible organic matter. This may occur in feeding large quantities of roots, especially when they are young and immature.

For many purposes in the animal body the fat of a food is believed to have a nourishing value much larger than the same weight of starch or sugar. For that reason each pound of it in the food is considered as being equivalent to 2.2 pounds of carbohydrates.

While it is not intended to deny that fat in a food may have some special action peculiar to itself and which cannot be supplied by carbohydrates, our knowledge of this subject is at present too meager to base any conclusions upon a slight

increase or decrease of fat in the food. All the foods given in the table contain at least some fat. In none of them is it excessive except cotton seed and cotton seed meal. It is well known that notwithstanding the large amount of oil which it contains cotton seed may be fed to cattle as an almost exclusive food without detriment to their health or fattening qualities. It is evident that the oil present in this seed replaces the carbohydrates which would be given in other foods.

Accordingly, with these facts in mind, instead of giving the carbohydrates and the fats separately in the tables given in this bulletin, both as to the requirements of the animal and the composition of the foods, they are combined under the head of nonnitrogenous matter. In doing this the amount of digestible fat in each food is multiplied by 2.2 before adding the amount to the digestible carbohydrates. This arrangement will simplify to a marked degree the compounding of the rations without destroying their accuracy.

Comparative Value of Foods.—In considering from a chemical standpoint, the relative value of different foods of the same class the most definite base, seems to be a comparison of the relative amounts of digestible food material which they contain. This may be found by taking from the table given the sum of the nitrogenous and nonnitrogenous substances. The special composition of a food as to its nutritive ratio may in some instances make it exceptionally valuable in that its use will increase the efficiency of other foods at the disposal of the feeder. To what extent foods can be profitably purchased at an increased price for such purposes is a question which at the present time must be ascertained for the most part by the judgment and experience of the feeder.

According to the best information at hand the propriety of valuing foods according to the amounts of nitrogenous matter which they contain is doubtful, and there does not seem to be evidence in support of what has heretofore been a common practice, of pronouncing a food superior because of its containing a large amount of protein or nitrogenous matter. Especially is this true in a district where nitrogenous foods are so abundant as in the cotton growing States at the present time.

The foregoing statements have reference to material simply as articles of food, for the purpose of supplying nourishment to the animal. It frequently happens in districts where animals are fed in the course of general farm practice, that much reliance must be put upon the value of the manure produced for profit from the feeding. In such cases the foods containing the largest amounts of nitrogenous matters will in many instances yield greatest profit because of the large amounts of nitrogen which the manure produced from them will contain. In fact, cotton seed meal, coarse bran, and some other substances are in some sections of the country worth quite as much as a manure, at the prices concentrated *manures sell in the markets, as they will cost. It so happens that in the feeding of animals the manure produced will contain nearly the entire amount of the more valuable manure elements of the food, namely, nitrogen, the phosphoric acid and the potash. Only very small portions of each of these are retained by the animal, and unlike carbon and some other elements of the food they are not liberated into the air. Thus the nutritive effect of these substances used as food is for the most part clear gain. In view of this fact that food containing the most nitrogen will at equal prices be the most profitable to purchase except in those cases where its

*For information on the valuation of manures see Bulletin No. 19, also Bulletin No. 24, page 139.

use would increase the proportion of nitrogenous matter in the food to an injurious extent.

The Calculation of Rations.—The coarse fodders of this State may, for the purpose in hand, be divided into three classes: The hay of grasses; the hay of leguminous plants, and straw and cotton seed hulls. Notwithstanding that the different kinds of grasses when analyzed and subjected to digestion tests show marked differences in composition and in food values, yet the differences are frequently so great for different plants of the same kind when cut at different stages of growth or grown under different conditions, that for ordinary use in the compounding of rations and in considering the value of such plants we may consider hay from all the grasses as practically identical. Making due allowance for the large amounts of water which it frequently contains, corn fodder, too, may be considered as having the same composition as the hay of grasses. So, too, the leguminous plants differ so little in composition from each other that to make distinctions between them for ordinary farm feeding is nearly or quite useless. Accordingly the following average figures for hay from grasses and from leguminous plants are given for use in compounding rations:

	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Hay of grasses	83.2	48.1	3 7	45.8
Nutritive ratio, 1:12.4.				
Indigestible matter in each 100 pounds of organic substance, 57.8.				
Hay of leguminous plants	80.0	46.9	8.5	40.0
Nutritive ratio, 1:4.7.				
Indigestible matter in each 100 pounds of organic substance, 58.6.				

Having at hand a quantity of food material and wishing to know in what amounts and proportions to feed to our animals to get the best results, we turn to the table of feeding

standards and find the requirements of the animal which we are to feed. Take a milch cow, for instance, and assume it to weigh 1,000 pounds. It will require 24 pounds of organic matter of which 15.4 pounds should be digestible. The digestible matter should be of such a nature that for every one part of nitrogenous matter present there will be *5.4 parts of nonnitrogenous matter. By referring to the supplementary table of feeding standards we find that to give the above conditions will require 2.5 pounds of digestible nitrogenous matter and †13.4 pounds of nonnitrogenous matter.

Supposing, now, that we have for feed, grass hay, corn meal and cotton seed meal. So far as known there is no definite rule by which the proportion of the ingredients may be ascertained. We must examine the table of their composition and exercise our judgment in combining them. To give the desired bulk it will require that about 20 pounds of the digestible matter should come from coarse fodders. This would take exactly 24 pounds of hay. The other 4 pounds of organic matter will come from the meals. By trial it is found that 1 pound of corn meal and 4 pounds cotton

*Information collected by the Wisconsin Experiment Station from a large number of dairies in various States, shows the average rations used at those dairies to be as follows for each 1,000 pounds of live weight per day:

Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Carbohydrates.	Digestible Fat.	Nutritive Ratio.
25.0	16.0	2.2	13.1	.7	1:6.8

Aside from this there are other good reasons for believing that a less quantity of nitrogenous matter might in many instances be used without loss and possibly with greater profit. However, foods rich in nitrogenous matter are not the most difficult to obtain in this State and the tendency is rather to make the ration narrower, that is, containing more nitrogenous matter.

The sum of 2.5 and 13.4 is 15.9 or .5 pound more than the digestible matter. This is due to the fat having been multiplied by 2.2 in finding the nonnitrogenous matter as explained on page 161.

seed meal will give very close to the required amounts as appears from the following:

	lbs.	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Hay of grasses	24	20.0	11.5	.89	11.0
Corn meal	1	.9	.8	.08	.8
Cotton seed meal	4	3.4	2.7	1.47	1.8
	29	24.3	15.0	2.44	13.6

Nutritive ratio, 1:5.6.

In a similar manner by using 1 pound of wheat middlings instead of the corn meal we obtain the following:

	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Ration for 1,000 pound live weight per day	24.3	14.9	2.47	13.4

Nutritive ratio, 1:5.4.

Cotton seed and pea hay are fodders of very common occurrence in this State. Owing to the comparatively large amount of protein which the hay contains and the large amount of indigestible matter in the cotton seed, we will reduce the hay to 20 pounds per day. This will give 1.7 pounds of digestible protein. The remaining .8 of a pound will come from cotton seed containing 9.8 pounds in each 100 pounds of seed. It will therefore take about 8 pounds of seed and we have the following:

	lbs.	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Cowpea hay	20	16.0	9.4	1.70	8.0
Cotton seed	8½	6.7	4.6	.83	5.5
	28½	22.7	14.0	2.53	13.5

In all the above rations the amount of digestible organic matter falls below that given in the table. This will always occur when there is a considerable proportion of oily foods such as cotton seed or cotton seed meal. An examination of the supplementary table will show the amounts of the nitrogenous and nonnitrogenous matters to agree very closely with the standard. This is of first importance for it is the sum of these that indicates the true nutritive value of the food.

In the same manner as we have found the rations for milch cows given above we find the following quantities of cotton seed and pea hay fill the requirements given in the table for the second feeding period of fattening steers:

	Weight lbs.	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Pea hay	22	17.6	10.3	1.87	8.8
Cotton seed	11½	9.1	6.3	1.12	7.5
	33½	26.7	16.6	2.99	16.3

In the final fattening of cattle, however, it would be better to use some corn rather than to increase the amount of cotton seed as would be necessary to give the desired ration. Hence we have:

	Weight bs.	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.
Pea hay	18	14.4	8.4	1.53	7.2
Cotton seed	8	6.3	4 4	.78	5.2
Corn meal	5	4.4	4.0	.39	3.8
	31	25.1	16.8	2.70	16.2

It being desired to feed the above ration to an animal weighing 800 pounds, the proper amounts may be found by multiplying the weight of each food by 800 and dividing the resulting products by 1,000. Thus we obtain the following: Pea hay, 14.4 pounds; cotton seed, 6.4 pounds; corn, 4 pounds.

It is apparent, therefore, that from the data given in this bulletin rations may be computed for the various animals fed upon the farm. In practice it will often be necessary to modify the computed rations to meet the needs of special animals. The individual peculiarities of each can be ascertained only by experience and observation on the part of the feeder. The tables will be of service in assisting the feeder to carry on his work in a systematic and intelligent manner.

G. L. TELLER.

Partial Composition of some Stock Foods Common to Arkansas.

	Water.	Ash.	Total Organic Matter.	Digestible Organic Matter	Digestible Nitrogenous Matter.	Digestible Nonnitrogenous Matter.	Indigestible Matter in each 100 lbs. of Organic Substance.
GREEN FODDERS.							
Corn fodder	79.3	1.2	19.5	13.6	1.4	12.6	30.2
Rye fodder	76.6	1.8	21.6	16.5	2.1	15.0	25.4
Oat fodder	62.2	2.5	35.3	26.1	2.7	24.6	26.1
Redtop	65.3	2.3	32.4	18.3	1.4	17.4	43.6
Orchard grass	73.0	2.0	25.0	13.4	1.5	12.4	46 4
Timothy	61.1	2.1	36.3	20.7	1.5	19.8	43.1
Red clover, before bloom	72.0	2 4	25.6	19.2	3.7	16.0	25 3
Red clover, in bloom	72.7	2.2	25.1	18 1	3.2	15.7	29 9
Red clover, after bloom and in seed	68.2	2.2	29.6	18.5	2.9	16.4	37 3
Alsike clover	74.8	2.0	23.2	14.1	2.4	12.2	39.1
Cowpea	83 6	1.7	14.7	8.9	1.7	7 4	39.2
Alfalfa	71.8	2.7	25.5	16.3	3.9	12.9	36 2
Corn silage	79.1	1.4	19.5	12.4	0.8	12.3	36.5
HAY AND COARSE DRY FODDER							
Redtop	8.9	5.2	85.9	44.5	3.9	41.7	48 2
Orchard grass	9.9	6.0	84.1	45.0	4.7	41.8	46.5
Timothy (in bloom)	15.0	4.5	80.5	45.4	2 9	44.2	43.6
Timothy (soon after bloom)	14.2	4.4	81.4	46.2	2.8	45.1	43.2
Oat hay	8.9	6.2	84.9	52.2	4.3	49 7	38.5
Red clover	15.3	6.2	78.5	49.3	8.1	43.8	37.2
Alsike clover	9.7	8.3	82.0	50.2	7.8	43.9	38.8
Peanut hay	11.5	7.6	80.0	58.3	7.3	39.1	54.1
White clover	9.7	8.3	82.0	52.5	11.5	42 7	36.0
Alfalfa	8.4	7.4	84.5	51.7	10.8	42.4	38 8
Cowpea	11.9	8.4	79.7	48.8	9.3	41.2	38.8
Corn leaves (pulled fodder)	8.9	9.7	81.4	48.1	6.6	44.0	40.9

Partial Composition of some Stock Foods Common to Arkansas.—(Continued.)

	Water.	Ash.	Total Organic Matter.	Digestible Organic Matter.	Digestible Nitrogenous matter.	Digestible Nonnitrogenous Matter.	Indigestible Matter
HAY AND COARSE DRY FODDER							
Corn fodder (field cured)	42.2	2.7	55.1	35.2	2.2	34.3	
Corn stover (field cured)	40.5	3.4	56.1	27.4	1.5	26.3	
Wheat straw	9.6	4.2	86.2	39.2	0.8	39.0	
Rye straw	7.1	3.2	89.7	43.8	0.7	43.5	
Oat straw	9.2	5.1	85.7	43 9	1.6	43.2	
Cotton seed hulls	9 9	2.9	87.2	29.0	1.0	30.2	
ROOTS AND TUBERS.							
Potatoes	78.9	1.0	20.1	16.5	1.3	15.6	
Sweet potatoes	71.1	1.0	27.9	23.4	0.9	22.9	
Mangel-wurzels	90.9	1.1	8.0	7.2	0.9	6.6	
Turnips	90.5	0.8	8.7	7.5	0.6	7.1	
Rutabagas	88.6	1.2	10.2	9.4	0.7	8.9	
GRAINS, SEEDS AND MILL PRODUCTS.							
Corn, dent varieties	10.6	1.5	87.9	79.1	7.8	76.4	
Corn and cob meal	15.1	1.5	83.4	65.7	6.5	62.7	
Corn bran	10.9	1.7	87.4	60.5	6.2	58.4	
Barley	10.9	2.4	86.7	74.9	8.7	68.1	
Oats	11.0	3.0	86.0	61.7	9.2	57.5	
Rye	11.6	1.9	86.5	75.0	8.3	68.1	
Wheat	10.5	1.8	87.7	75.5	9.2	68.0	
Wheat bran	11.9	5.8	82.3	68.9	11.2	62.0	
Wheat middlings	12.1	3.3	84.6	72.4	11 3	65 3	
Wheat shorts	11.8	4.6	83.6	70.7	10.8	64.6	
Cotton seed	17.5	3.5	79.0	54.6	9.8	65.0	
Cotton seed meal	8.2	7.2	84.6	67.9	36.7	46.3	
Cow pea	14.8	3,2	82.0	73 6	18.3	56.6	

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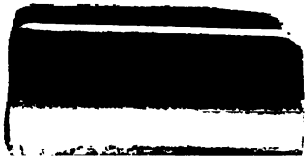
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